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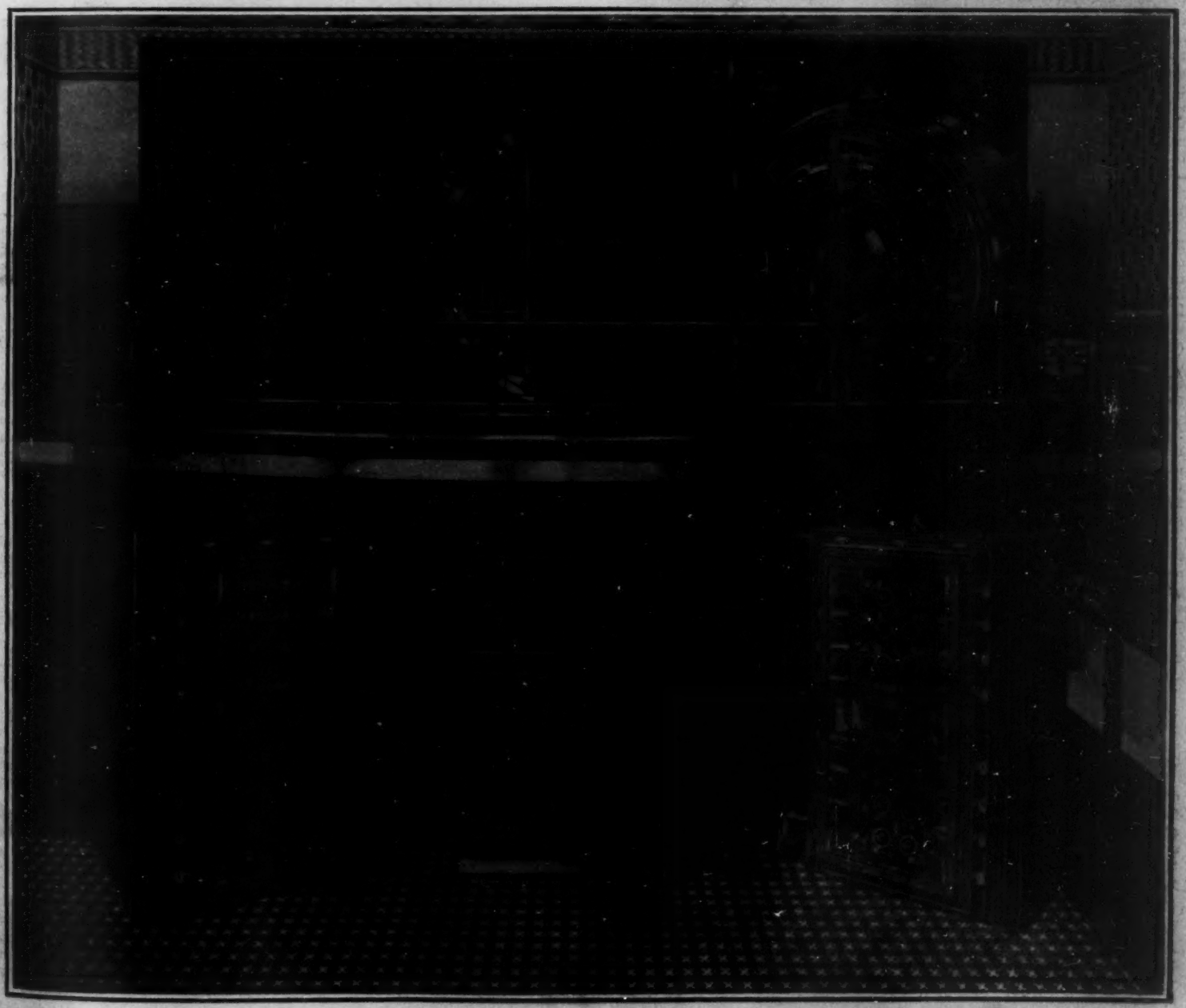

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ARMOR PLATE—THE LAST ANSWER OF THE BANKER TO THE BURGLAR.—[See page 325.]

SCIENTIFIC AMERICAN

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NEW YORK, SATURDAY, APRIL 21, 1906.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

INTERNATIONAL PROTECTION OF NIAGARA FALLS.

Joint international action by the United States and Canada for the preservation of the scenic beauties of Niagara Falls is an assured fact. Representative Burton, of Ohio, has laid before Congress a proposition for diplomatic action with Great Britain which, in the event of favorable action, will give the Secretary of War authority to grant revocable permits for diversion of water from Niagara River "only to individuals, companies, or corporations, which are now actually producing power from said water, and to them only to the amount now actually in use by such individuals, companies, or corporations." On the other hand, the Canadian Minister of Public Works has announced at the Canadian capital a federal policy to preserve Niagara Falls. Under this policy the right to export electric energy into the United States will be granted under the understanding that it can be revoked at short notice, and that there shall be no claim against the government arising out of such revocation, and, moreover, that the companies shall be subject to such regulations as the government may impose. It seems that, as far as the Canadian side is concerned, the export of power to the United States is the most serious danger confronting the Falls, and the fact that the Canadian government should so soon have placed an embargo on exportation may be taken as evidence of its desire to co-operate with the United States in this important matter.

THE ENGLISH CHANNEL TUNNEL.

It is natural that the friendly relations lately established between Great Britain and France should encourage the promoters of the project for a tunnel beneath the English Channel to make another effort to obtain the necessary sanction of the British government. The Société Français du Tunnel Sous-Marin was incorporated in the early seventies for the purpose of carrying out this great work. A shaft was sunk on the French side of the Channel at a point about six miles from Calais, and the English terminus was fixed near to Dover. A considerable amount of tunneling was done by the French company; but after they had spent about half a million dollars, the British government put a stop to the work on the English end, ostensibly for the reason that a tunnel beneath the Channel would destroy the security which Great Britain's insular position afforded, and would render her liable to attack by an invading army.

Engineers of the Northern Railway of France have recently made an investigation of the abandoned works and found them to be in good condition, and it is probable that the present session of Parliament will witness the introduction of a bill for permitting the work to proceed on the English side. The tunnel would be an ideal one to drive, as practically the whole of its 23½ miles of length will pass through a firm but easily-quarried chalk, which it is believed is free from faults. This would make it possible to drive the tunnel without the use of the pneumatic process, or the necessity for serious pumping operations. Apart from military considerations which, in themselves, cannot have much weight because of the tunnel's limited capacity and ease of destruction, there is much to be said in favor of the proposed tunnel. The Dover-Calais passage is notoriously rough and uncomfortable, and the substitution of an all-rail route between London and Paris, would be a decided boon to hundreds of thousands of travelers between England and the Continent.

ELECTRIC EQUIPMENT OF A GREAT RAILROAD.

The magnitude of the work involved in the equipment of the New York Central terminal and suburban lines looms so large before the public that the great work of electrically equipping the New Haven system is scarcely receiving the attention it deserves. This important four-track system is to be operated from the Grand Central station terminal to Stamford entirely by electric locomotives, and the work of equipping the line and constructing the rolling stock is being rapidly pushed forward with a view to the earliest possible operation of the road. The problem confronting the New Haven company has been complicated by the fact that they have decided to use the single-phase alternating current, although for a considerable distance the trains must run over the tracks of the New York Central company, which are to be equipped with the direct current. The motors will be so constructed that they can run on single-phase current on the lines of the New Haven company, and then make use of the direct current from Woodlawn to the Grand Central Station, running as direct-current motors over the 11 miles intervening between those points, the power for train operation being purchased from the New York Central. East of Woodlawn the trains will take current from a new power station which is being built by the New Haven company at Cos Cob. The steam-generating equipment will consist of 9,000-horse-power water-tube boilers, which will supply steam to 3,000-kilowatt Parsons steam turbines. The generators will supply single-phase, 25-cycle, 11,000-volt current; but they will be so wound that, if it is desired, they can deliver three-phase current. Power will be distributed at the high potential of 11,000 volts, and therefore no step-up transformers will be needed. Instead of the customary third rail, overhead wires will be used. The locomotives will be of the Westinghouse type, and will weigh about 72 tons each, and all of the axles will be used as driving axles. The locomotive will be carried upon two trucks, each of which will be equipped with two 250-horse-power single-phase, gearless motors. An important feature in the suspension is that the weight of both the armature and the field is spring-supported. The figures of cost of the installation are interesting as showing the relative expenditure that must be made upon power house, overhead lines, and locomotives, the power house costing $1,130,000, the line, of which there will be 21 miles four-track, costing $570,000, and the locomotives $1,050,000. It is probable that the success of this first installation will be followed by similar equipment of zones extending around other principal cities on the New Haven system. Ultimately the extension of these zones to a junction with one another will eliminate the steam locomotive, and leave the whole system to electric operation. Because of its vast suburban and interurban business, we think that the New Haven system is perhaps better placed for the wholesale application of electric traction than any other of the large trunk roads of the country.

UNIFORMITY IN BATTLESHIPS.

It has long been recognized by naval men that a fleet which is made up of heterogeneous types of ships, that is of ships of different size, speed, armament, and protection, is at a great disadvantage from a tactical point of view when it encounters a fleet of the same total displacement whose ships are arranged in groups of identical vessels. Recent naval operations have emphasized very strongly the truth of this principle, and the best-organized navies of to-day are building their ships in groups or classes of four, six, or eight. Ships of such a group have the great advantage that their speed, their coal endurance, and their turning diameter are identical, and that in the various evolutions the vessels will, in their new positions, find themselves at all times grouped symmetrically.

It is earnestly desired by our Navy Department that when new ships are authorized, they shall conform to some existing design until they have been brought up to the proper number of units to form a class, say of half a dozen; and they are naturally opposed to the construction of any new type of vessel which is not likely to be repeated sufficiently often to form a new group.

The decision of the House Committee on Naval Affairs to recommend an appropriation for the construction of a battleship which, in size and power, will surpass any ship at present under construction, has naturally appealed to the non-professional world, or rather to that section of it which believes that there is a certain national prestige conveyed by the possession of a "world-beater"; but our naval constructors, who have learned to subordinate sentiment to reason and cold facts, look very unfavorably on the proposition. They are well aware that, although we are perfectly well able to build a 20,000-ton ship of 20 knots speed, such a vessel would be in a class all by itself, and, when maneuvering in the company of smaller, slower, and less powerful ships, would have to accommodate herself to their limitations, and therefore would be unable to realize in action her full efficiency. The plans proposed for our latest ships, the "Michigan" and "South Carolina," will give us a magnificent ship, of which we ought to build at least half a dozen before launching out into new types.

Although our earlier battleships differ widely in type, our later ships resolve themselves into classes, each composed of about five or six units. Thus, the three ships of the "Maine" type and the three of the "Illinois" type give us a class of six approximately similar ships. In the "Virginia" class we have five ships absolutely identical; in the "Louisiana," "Vermont," and "New Hampshire" classes we have six practically identical battleships in which the "Mississippi" and "Idaho," were it not for their low speed, might possibly be included, bringing the number up to eight; while in the "South Carolina" and "Michigan," our latest designs, we have a class which, as we have said, should be extended until it includes five or six identical vessels. By the time Congress has made sufficient appropriation for this purpose, the Navy Department will have formulated its ideas as to the best type of vessel to build, if we decide to construct ships of 18,000 to 20,000 tons displacement.

But it will be an unhappy day for the Navy Department if the Bureau of Construction is to be controlled by any popular "whip creation" theories of warship construction.

THE DEVELOPMENT OF AERIAL NAVIGATION FOR MILITARY PURPOSES IN EUROPE.

Owing to the success that has attended the various trials carried out by the French military authorities with the Lebaudy airship, aerial navigation for military purposes is being rapidly developed upon an extensive scale by the prominent European powers. France is particularly energetic in this direction, and has now adopted another airship (the invention of M. Juilliot, an engineer in the army) the experiments with which have been conspicuously successful. Under these circumstances the War Department realizes that the time has come when the development of this new scientific aid to military operations should be carried out upon an organized basis. For this purpose there has been initiated a corps of "balloon scouts," the members of which are to be drawn from the officers in the army whose examinations demonstrate their capacity for the work of the new department. The "*observateurs en ballon*," as they are officially designated, will not act as aeronauts simply, but are to be employed more for strategical work, for which their training in the field and siege artillery sections renders them especially serviceable. The inauguration of this special corps is the outcome of the successful reconnoitering operations that were carried out from the Lebaudy airship during its trip along the eastern frontier.

The members of this corps will be selected on account of their light weight, particularly good sight, and their proficiency in rapid and accurate topographical drawing, since their operations will be confined mostly to the acquisition of information of an enemy's position both before and during an action and the conveyance of such information to headquarters. The aerostats are provided with a full equipment for accomplishing this end. The members of this corps will pass through three months' training in military aeronautics with the special battalion of aeronaut engineers.

In Great Britain, also, military ballooning is being rapidly developed and extended. The balloon factory at Aldershot is to be completely overhauled, and $50,000 expended in new equipment during the coming year. Owing to the success that has attended the experiments that have been carried out by the War Office with the Cody man-lifting kites, a special instructor for this work has been appointed at a salary of $3,000 per annum, and the kite-flying division will constitute a section of the balloon department.

Several improvements have been effected during the past few months with the Cody kites, the inventor having been retained by the War Office for the work of initiating the men into the work. The results achieved have been completely successful, the basket attached to the kites easily lifting a man of 240 pounds in weight to a height of 3,000 feet. Owing to the steadiness with which the kites ride in the air surveying and drawing by the officer in the basket can be easily and comfortably carried out, while messages can be carried between the surveyor and the ground station by means of the telephone carried by the wire.

The department is now engaged in experiments with a "glider," which has been devised by Capt. Cody. This comprises a long double-banked framework of bamboo, upon which is stretched calico. The wings are long and narrow, and arranged one above the other on either side of the body in much the same way as the wings of a dragon fly. The aeroplanes, however, are quite stationary. Along the front edge, however, is a slight curvature, which can be lessened or increased as desired by the operator, who lies prone in a net slung beneath the center or body of the machine. The glider is released from an eminence or balloon in much the same way as a parachute, and the operator is able to regulate his descent by the manipulation of the wings. The greatest height from which this glider has been released is 500 feet, and the aeronaut has successfully glided a distance of half a mile before coming to earth. Experiments have shown that it is possible to descend from this elevation to any desired point, even the sharpest descents in point of angle being accomplished

without any injury to the operator. Flights from higher elevations are to be carried out, but for these the aeroplane is to be provided with a tail piece, which it is anticipated will enable the machine to be more easily controlled.

During the next few months, also, the first trials with the dirigible airship invented by Col. Templer, the head of the war ballooning department, are to be carried out. The inventor has been engaged upon this aerostat for several years past, and has been assisted in his efforts by the War Department. The design of this aerostat follows the usual lines, comprising a cigar-shaped gas vessel 140 feet in length by 25 feet in diameter at the center. Its capacity is about 70,000 cubic feet of hydrogen, and the lifting power is over 6,750 pounds, though the structure itself weighs 1,200 pounds. It is most strongly constructed, the material of the gas envelope being of great thickness, so as to resist tearing and cracking. It is ribbed diagonally and inclosed in a network of fine cord. So stoutly is the envelope constructed, that when inflated the balloon is as solid as a football, and one can walk over it without making the slightest indentation.

Forty feet below the gas bag is suspended a light wicker frame-work shaped like a whaleboat. This carries the 40-horse-power gasoline motor sets, which are of special type, and the disposition of which is carried out upon novel lines. At either end of the frame-work are placed the propellers, the experiments with which show that in calm weather a speed of twenty miles an hour should be attained. The steering of the airship is effected upon novel lines. The construction of this vessel has been carried on with great secrecy in a house specially provided for the purpose. The vessel is, however, now completed, and the trials will take place at the first favorable opportunity. The vessel has been three years under construction, and the inventor has been able to eliminate those features which experiments by other inventors during this period have proved to be either unsatisfactory or useless.

The German military department has also decided to exploit the subject. The work, however, will not be carried out by the government, but by private enterprise, a company having been especially incorporated in Berlin under the influence of the Kaiser for this purpose. The object of this company will be to examine and test the various airships constructed in the anticipation that one suitable to military requirements may be discovered.

CANALS AND RAILWAYS IN INDIA.

BY L. H. YATES.

Some important facts and figures relating to the respective values of canals and railways in India were laid before the Society of Arts, London, quite recently. Mr. R. B. Buckley, C.S.I., wished to point out that there ought not to be any rivalry between the two modes of transit, when rightly and fairly considered, and others who spoke after his paper had been read indorsed this opinion. Both methods are necessary for the full development of a country, and both tend to increase the total volume of trade. The point where friction arises in India is that the government readily grants free land to the railway companies, and guarantees the payment of interest on their capital outlay, while the navigation companies can obtain no help at all, and, save in a few instances, the government is unwilling to spend anything on maintaining even the original great waterways.

Making a few comparisons between railways and canals, with reference to their profit to the state, the reader of the paper pointed out that the Bengal Central Railway, since its opening in 1881, has been worked at a gross loss of £400,000, after the guaranteed interest of 3½ per cent has been paid. During the same period, the Calcutta and Eastern canals, taking interest at the same rate, had worked at a profit to the state of £25,000. "This," said he, "is a fair case in which a canal working side by side with a railway has held its own against competition, and the example gives force to the contention that it is to the interest of a country that money should be spent on navigable waterways." He did not grudge the expenditure of 235 millions on the railways of India in the last half century, but the five millions spent on her waterways had been totally inadequate and disproportionate. The Assam-Bengal Railway provides another instance of unequal treatment. The trade which passes between Bengal and Assam is, next to the domestic trade of Bengal itself, the most important of the whole country, and roughly speaking, one-third goes by rail and two-thirds by water. The railway runs through from Chittagong to Johat and Dibrughur, and will in a short time be connected with Calcutta. While it is of great benefit and convenience, it is worked at a heavy loss to the state, though constructed and worked by a company, with a guarantee of 3 per cent interest payment. The capital expended by the end of 1904 amounted to £8,400,000, and after meeting interest charges the loss on the working of the line was in 1903, £93,000; in 1900 it was £200,000; and in 1904, £270,000. "This," said Mr. Buckley, "is an example of the price which the state pays from the general revenues, for benefits which the railway is supposed to confer."

The Honorable East India Company was the first to organize steam traffic on the Bengal waterways, and so far back as 1834 the business had become a very profitable one, and by then a regular line of steamers was running from Calcutta to Allahabad. Now the traffic is worked by different companies, with large fleets of steamers and flats. These companies have no guarantee on their capital and receive no contribution from the state toward the payment of their interest, but during the years in which eight millions sterling have been spent on the construction of the Assam-Bengal line, the only large improvement here made, that on the Bhil route, has cost £50,000, and this brought in last year a direct net revenue of about £2,500, or 5 per cent on its cost. No doubt the returns from the railway will improve in time, and the reasons which determined its construction were, perhaps wisely, largely independent of its financial success, but the marked difference between it and the treatment of the navigation companies has led to much sore feeling, in consideration of their respective returns.

The greater number of the canals in India have, of course, been primarily constructed for irrigation—for the preservation and improvement of agricultural crops. But in a number of cases the main canals have been so constructed that they might be used for navigation as well as for irrigation, and there are three important canals in India which have been constructed for navigation only, with several minor ones of the same class. About one-fourth of the aggregate length of irrigation canals in India has been made navigable. The cost of the purely navigation canals has been about a million and a half sterling. These canals are in immediate contact with the tidal creeks and rivers connected with the Bay of Bengal; indeed, the greater portion of the Circular and Eastern Canal, which connects Calcutta and Barisaul in Eastern Bengal, consists of natural tidal channels artificially improved. The Calcutta and Eastern Canal is in many respects a remarkable work, not only in construction, but because it is one of the few instances where the government has itself undertaken to improve it by outlay of money. The canal itself runs generally east and west, while the various channels, or "gongs," as they are called, which are connected with the Bay of Bengal, run generally north and south. These gongs are mostly tidal, so that the general ebb and flow of the tide is more or less at right angles with the line of the canal. The main channels are linked together by an intricate system of cross streams, which intersect the forest of the Sunderbunds in all directions, so that it is always possible to find a way from one gong to another. The canal has, in fact, utilized a system of cross channels between the main gongs to some extent; in other instances artificial cross channels have been made.

It has been maintained that it is at least desirable, if not necessary, to make the trunk lines of an irrigation system navigable, in order that an easy and cheap means of transit may be provided for grain and other crops. It is said that the expense of the additional work is not large, while the convenience to the people is very great. But after going into the question at considerable length, and giving the various causes which make for and against the feasibility of altering the construction from one system to another, Mr. Buckley had reached the conclusion that, taking all things into consideration, the difference of cost between a canal designed purely for irrigation, and one adapted from that for navigation also, is from £1,500 to £2,000 per mile. The profits on navigable waterways are almost solely found on the purely navigation canals. The Orissa Coast, the Calcutta and Eastern, and the Buckingham Canal, bring in more revenue than all the others combined. The obvious reason for this is that the navigation canals follow trade routes, while canals designed primarily for irrigation do not. The latter, when navigable, are useful to the people whose villages are near them, but seeing that, taken collectively, the irrigation systems of India pay 7 per cent on their cost, it should hardly be a matter for objection if in one function they are not altogether satisfactory. On all Indian canals tolls are charged on the boats which use them. It may not be strictly accurate to say that in all countries save England and India the canals are free, but it is true in the main. In France, in Italy, and in Austria-Hungary (with the exception of the Iron Gates Canal) no tolls are levied on navigation; in Belgium and Germany, though tolls are charged, they are very low; in the United States and Canada all are free save those which are not the property of the state. In Egypt tolls were abolished in 1901. It would seem as if the time had come when the government of India should consider the desirability of leaving the navigation of the canals as free as is the traffic of the roads.

It was pointed out by a speaker, after the reading of Mr. Buckley's paper, that the greatest service rendered by the smaller canals was that of providing roads in districts where roads on land were difficult to maintain. Small canals between rivers would serve really important agricultural districts much better, indeed, than roads, and in thus catering for local interests there was a much better prospect for their becoming financially successful than in any attempt to make them compete with rival routes and leading lines.

A writer on the subject of "British Canals" said that where canals do not pay *per se*, they pay by increasing the volume of trade. This was the reason why France and Germany found it profitable to spend so largely on the development of their canal systems, and the trade increase they could show was the proof. In the case of the Manchester Ship Canal, this was strikingly brought out; in itself it was a failure, financially considered, but since its opening and working an enormous number of industries had sprung up which could never have arisen had not the canal been there first, and so it was with many other canals. If a community benefited as a whole by the expenditure made upon these objects, there ought to be no thought of antagonism as to the respective merits of each means; all deserved their share of support, and from the state at least, all deserved equal consideration.

MOSQUITO EXTERMINATION.

This is another name for the prevention of mosquito breeding by obliterating the primary conditions requisite for their wholesale production. On the 11th instant the Third Annual Convention of the American Mosquito Extermination Society was held in this city, at the New York Aquarium, and supplemented in the evening by a dinner given at the Union League Club by the President, Mr. Wm. J. Matheson, in honor of several guests and Health Board officials.

At the convention it was shown that much progress had been made toward the abatement of the mosquito nuisance by a greater enlightenment of public sentiment in its favor, as evidenced through recent legislative enactments.

In the State of New Jersey, for example, where only a few years ago the suggestion of eliminating the mosquito met with ridicule, now, as a result of a more universal education and extension of information on the subject, it is reported that the State Legislature has passed almost unanimously an appropriation of $350,000, to be expended at the rate of $50,000 per year for the diking and ditching of the great salt marshes lying adjacent to the city of Newark and about the Hackensack River. Legislation is also in process in the New York Legislature to the same end for the benefit of New York city.

The convention adopted what is termed a "Mosquito Brief," stating in simple language the number of species of mosquitoes that inhabit marsh lands and cesspools of the United States—that they can only breed in water; that one mosquito can lay on the average three hundred eggs a day; that the life of one mosquito is about a month. The most dangerous of Southern mosquitoes is the *Stegomyia fasciata*, the natural carrier of yellow fever germs.

At the evening dinner, Gen. Fred D. Grant, of Governor's Island, U. S. army post, gave some interesting reminiscences on mosquitoes and their effect on the health of the army. He related how he had protected a division of the army located on one side of the Rio Grande River, in a southern section of the country, from the spread of yellow fever, which had broken out in a town situated on the opposite bank. He secured funds from Washington to carry out an effective system of screening, and said as a result that not one of his men was taken with the fever. On Governor's Island, numerous relics in the shape of 15-inch-gun shells were inverted, so as to shed water instead of holding it, which had the effect of relieving locally the generation of the insects. Even upright rifle barrels were filled with sand to avoid the collection of water.

Mr. Paul D. Cravath related an interesting record concerning the relation of the mosquito to malaria. On the north side of Long Island, about thirty miles from New York, there were certain valleys and bays where the mosquito was notoriously evident. The areas were located upon a map. Another record was made as to the extent of malaria over this section, from physicians and others, and these areas were placed upon a second duplicate map. This medical map was then superimposed over the first map, and it was found the areas in both cases pretty evenly matched each other.

This record is of special interest to all boards of health, and proves most graphically how it is possible to improve the public health by the prevention of mosquito breeding.

Other interesting remarks were made, showing how marshy places by being reclaimed and converted into public parks could easily improve land valuations and at the same time become a public benefit.

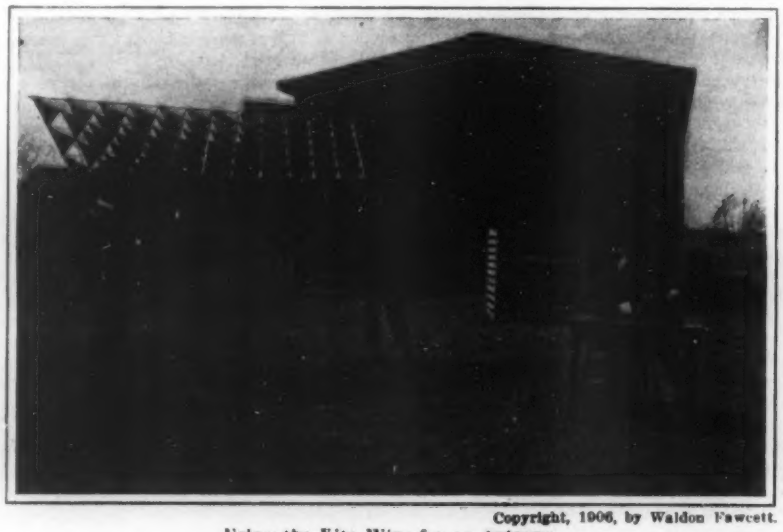
The United States gasoline torpedo is now an official weapon. Its speed is 36 knots.

THE BELL TETRAHEDRAL KITE IN WIRELESS TELEGRAPHY.

The announcement has recently been made by the American De Forest Wireless Telegraph Company of the successful transmission of messages from Manhattan Beach, Long Island, to Glengarriff harbor, County of Cork, Ireland. The station at Manhattan Beach, which was only quite recently completed, has a 40-kilowatt (54-horse-power) equipment. The current is stepped up to a pressure of 30,000 volts. The aerial is supported by masts 210 feet high. At Glengarriff the messages were received on aerials supported by kites. It is interesting to note that the first wireless signal across the Atlantic, that of Marconi in 1901, was also received by means of a kite-supported aerial at St. Johns, Newfoundland. In fact, Marconi's original patent suggested the use of kites or captive balloons to support the aerials. His idea then, however, was to coat the kite or balloon with tinfoil or some other metallic substance, so that it would afford an inductive capacity at the upper end of the antenna. Such a capacity is now no longer considered of any great benefit, and is not used on any of the present systems. The advantage of a kite or balloon support is that it will carry the aerial to a much greater height than is possible with a fixed mast. The antennæ will then intercept waves which are too high to be affected by earth currents. The reason kites have not been more universally adopted is that they are usually rather uncertain in their action. A sudden squall or a change in the direction of the wind will send them swooping toward the ground. A balloon offers the same disadvantages, with the additional one that the gas is liable to leak out and permit the aerial to drop to the ground. In the Marconi experiments hexagonal kites were used. Tests have also been made with tailless Malay kites and Blue Hill box kites. All of these, however, are open to the same objections of unsteadiness and unreliability.

In the De Forest experiments the effort was made to discover a kite which would ride steadily under the most adverse conditions. These desiderata were found in Prof. Alexander Graham Bell's tetrahedral kites. We have recently described Prof. Bell's kites very fully, and a further description of them here is not necessary. Suffice it to say that they are made up of series of cells consisting of triangular pyramidal skeleton frames, two sides of each pyramid or tetrahedron being covered with silk, while the others are left open. With this construction Prof. Bell found that a perfect equilibrium could be maintained. The kite rode steadily in the air, and did not swing from side to side or dive suddenly when struck by a squall. Even when released it maintained its equilibrium, and settled slowly and gently to the ground without oscillating.

Before carrying on experiments with transatlantic wireless telegraphy, tests of these kites were made at Arlington, Va. The accompanying illustrations are reproductions of photographs taken at these tests. One of the photographs shows the pilot kite, which was sent up to determine atmospheric conditions in the upper strata of air before the main kite was sent up. The antenna wire was attached to the kite wire, and carried up to heights ranging from 1,000 to 2,000 feet. Both aluminium and light copper wire were tried. At this altitude messages were easily picked up from vessels many miles out at sea and from stations all along the coast. It was found that the kites flew steadily, and could be kept in the air continuously day and night regardless of changes in the direction of the wind. An attendant had to pay out the line or reel it in as required, but no other attention was necessary. Occasionally a rain storm would wet the kite, and increase its weight sufficiently to drag it down. But as it fell, the kite wire would be reeled in, and a level would finally be reached where the weight of the wire reeled in would compensate for the increased weight of the water-soaked silk, and at this level the kite would remain. The experiments proved that the kites were proof against all conditions except a snow storm, which might weigh it down, or a violent gale or hail storm, which might destroy it. The purpose of the experiments at Glengarriff was to facilitate attuning the station at that point with the one at Manhattan Beach. After the necessary attunement has been attained, it is expected that messages can be easily transmitted to aerials supported by stationary masts. The kite-supported aerials are, therefore, experiments of a temporary nature. It is expected that kite-supported aerials will prove of great value for temporary stations, such as would be necessary in reporting a yacht race, for example, or some other event in a locality where it would be inexpedient to establish a permanent station.



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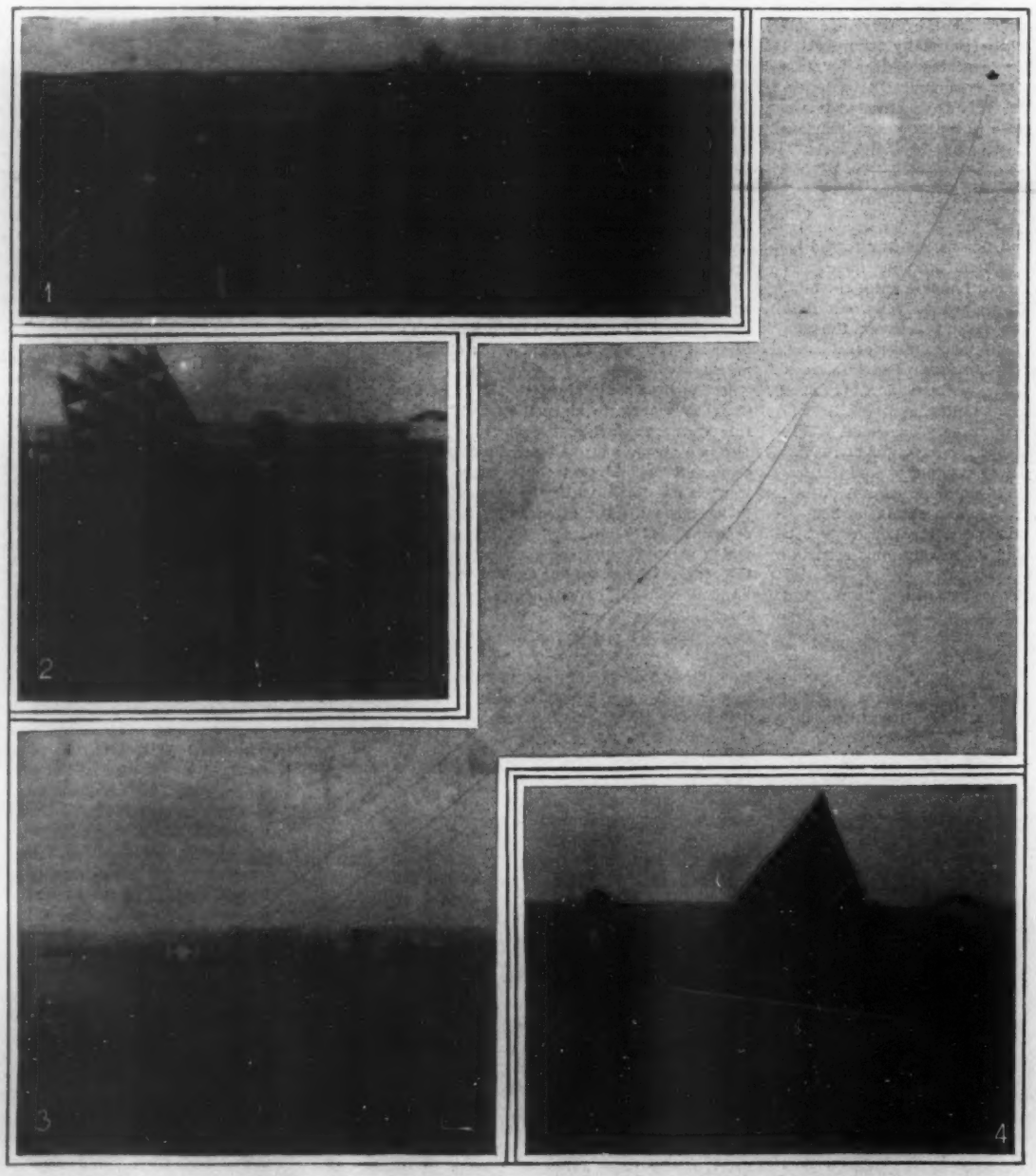
Using the Kite Wire for an Antenna.



1. Prof. Bell's New Kite for Wireless Telegraph Experiments. 2. Small Pilot Kite Sent Up in Advance of Main Kite. 3. Receiving Messages with a Kite-Supported Aerial. 4. End View of the Tetrahedral Kite.

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THE BELL TETRAHEDRAL KITE IN WIRELESS TELEGRAPHY.

Although the chemical methods of estimating the strength of wheat have as yet proved inconclusive, some idea of the factors determining this quality has been reached from practical baking tests combined with measurements of the gluten and nitrogen content of the flour. In the first place manuring proves a very small factor; it is found that the composition of the grain of wheat is extraordinarily stable and the plant reacts to diversities in nutrition by producing more or less grain rather than by altering its composition. Even under the exceptionally pronounced variations in the manurial conditions of the Rothamsted plots, the composition of the grain fluctuates more with changing seasons than with changed manuring. Within the limits of healthy growth and ripening the date of sowing the wheat has no effect upon the quality of the grain; the same wheat sown at monthly intervals from October to March gave practically identical quality in the grain, and a number of comparisons between autumn and spring sowing led to no definite conclusion.

ARMOR PLATE—THE LAST ANSWER OF THE BANKER TO THE BURGLAR.

The banks and trust companies are steadily raising the standard of excellence required in the construction of their vaults. Time was when the term "burglar-proof" stood for the high-water mark of vault construction; and the vault which could not withstand the attack of a first-class cracksman, operating under normal conditions, was not considered to be of a quality entitled to be called first-class. To-day, however, the demand is being made that a vault shall be able to resist attack under abnormal conditions. It might happen that through the distraction caused by a city conflagration, or the failure of the civil authorities to exercise their power, the professional cracksman or the lawless element might find themselves in a position to operate upon a safe without fear of immediate detection. Under these conditions they could bring to bear methods of attack which would be impossible under normal conditions; and the financial institutions are demanding that the modern vault shall be proof even against this. Moreover, events in Russia have shown that although this is an age of advanced civilization, it is possible for communities to fall into the hands of rioters and remain in their control for.

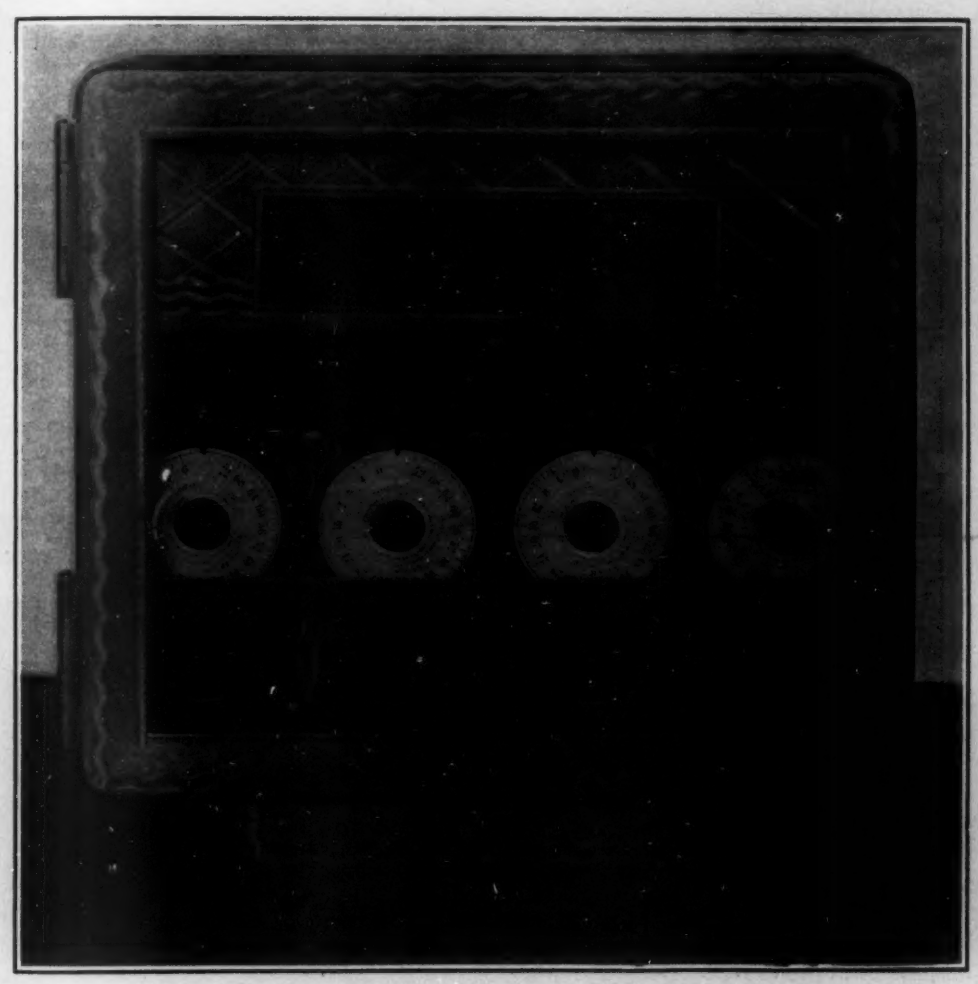
By the courtesy of Mr. W. H. Hollar, president of the Hollar Company, engineers and superintendents of bank vault construction, we were recently given an opportunity to inspect the massive safe deposit vaults designed by that company for the Provident Life and Trust Company, of Philadelphia, Pa., which form one of the subjects of our front-page engraving. This illustration is admirably adapted to our purpose, since it exhibits the two latest steps in the development of the high-class treasury and safe deposit vault, the lower vault being of the laminated, or five-ply, built-up type, and the upper vault representing the latest armor-plate construction.

The prototype of the present highly-developed safety vault is to be found in the old strong box, built of oak, clamped with iron, and provided with massive hasp and lock, of which not a few may be found to-day still standing in the ancient cathedrals and municipal buildings of Europe, where, centuries ago, they were doing useful service. It was a natural step from the iron-bound, wooden chest to the iron box, and from that to the all-iron vault half an inch in thickness, which, a century ago, represented the best that our forefathers could produce in the art of vault construction. A structure of this kind, secured by the simple contrivance of a large hasp and padlock, was easy prey to the burglar; and although as time went on the thickness was gradually increased, and the workmanship at the joints improved, the vault breaker continued to have the best of the struggle against the vault designer and maker, and the latter had to face the alternative either of making some radical change in his materials and methods of construction, or of admitting himself beaten in the struggle.

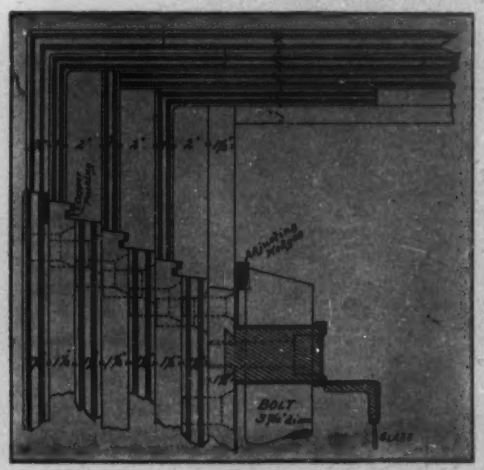
The next answer made by the vault maker to the burglar was the introduction of steel in place of iron, and the fabrication of the steel so that its high qualities of hardness and toughness should both be offered to the best advantage in resisting the improved tools and appliances of the safe breaker. The great requisites in a vault are toughness to withstand stripping, impact, or hammering effects, and intense hardness to resist attack by the drill. And just here the vault makers found themselves confronted by the same conditions as the armor-plate makers. The latter had to provide a plate that was hard enough to resist the attack of the intensely hard steel projectiles, and that still possessed sufficient toughness to prevent it from being cracked or entirely shattered by the impact. The armor-plate makers of twenty years ago solved, or tried to solve, the problem by taking a soft-steel body and rolling down upon it, at a welding heat, a face, several inches thick, of high-carbon steel, the idea being that the hard face would resist penetration and smash up the projectile, while the softer body would hold the hard face up to its work.

The vault manufacturer, on the other hand, met the attack of the drill and the dynamite charge by producing what is known as the five-ply welded plate, which consists of five welded layers, three of which are mild or tough steel, and the two others of extremely hard chrome steel. The two outer layers are of tough steel, the two next layers are of hard steel, and the center is a somewhat thicker layer of tough steel. It is made as follows: The plates of tough steel are raised to a welding heat, and high-chrome steel, in a molten condition, is run in between them. The whole plate is then rolled down to the desired thickness, which will vary from ⅝ inch to 2 inches, as desired by the manufacturer.

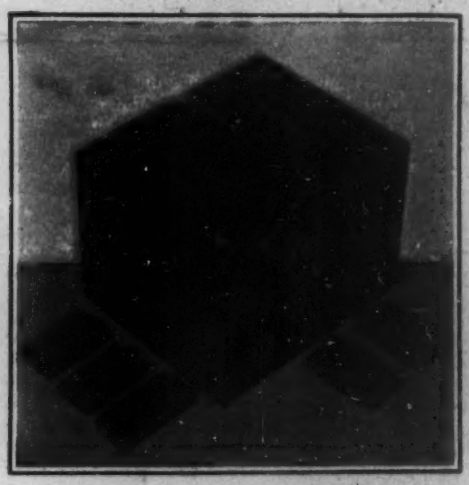
With the production of the five-ply plate the vault makers were in a position, for the first time, to offer a structure that was honestly entitled to be called "burglar proof" against the methods of attack which were common at the time of its production. It was



Front View of Hollar's Quadruple-Movement Electrical-Winding Time-Lock.



Section Through Door and Corner of a Laminated Five-Ply Vault.



Model Showing the Method of Jointing the Armor-plate Walls at the Corners.

ARMOR PLATE—THE LAST ANSWER OF THE BANKER TO THE BURGLAR.

days together, and it requires but little imagination to foresee a leader directing a mob to the accumulated treasure of others. The great wealth stored in vaults must, in such a case, become a natural object of attack, and with unlimited time and means at command, they would be subjected to treatment which the mere burglar-proof construction could never withstand. It was in the search for special material and methods of construction that would be proof even against such a contingency, that the vault engineer was finally led to turn his attention to the question of using face-hardened Harveyized armor plate.

As the readers of the SCIENTIFIC AMERICAN are well aware, we have at various times illustrated the manufacture of armor plate, and explained the special qualities which enable it to present such great resisting qualities to the attack of high explosives and large-caliber projectiles. In the following article we propose to trace, briefly, the development of the use of special material in vault construction, from the elementary sheet-iron box one-half inch in thickness to the latest splendid product of the art, consisting of face-hardened Harveyized plates from 5 to 16 inches in thickness, so securely dovetailed and locked together as to render the construction proof against any conceivable method of attack.

tough to resist the impact and shock of high explosives, and its hard-steel layers were sufficient to break the best steel drills of the burglar. But inasmuch as it was necessary, in order to secure the best results from the five-ply plate, to roll it down to comparatively thin sizes, it became imperative to devise some method of building up the walls of a vault to the desired thickness by the use of several of these plates, and of fastening the plates each to the other and bending and securing them together at the joints, which would be proof against attack. Each layer is fastened to the one outside of it by heavy countersunk tap screws, which are tapped into the adjoining plate. In this method of construction the screws, which are, of course, all put in from the inside, are arranged to break joint, as it were, as are also the various horizontal and vertical layers of plates. The result is that the final vault wall, as built up, has the nearest approach attainable to a homogeneous strength throughout, and is thus brought as near as possible to the ideal conditions presented by the single solid Harveyized plate. The whole of the work, as thus assembled, both in the walls and in the angles, is fastened together with heavy tap screws from the inside, and it follows, therefore, that the maximum strength of the construction consists in the aggregate strength

of the screws securing the several layers of metal together, and not in the mass of metal itself.

The five-ply type of vault has had a most successful career, and has been built in all sizes, from the small vaults of the country bank up to the imposing structure shown on our front-page engraving. Of the two vaults there represented, the upper one is of the latest armor-plate type, and was built by the Bethlehem Steel Company, and the lower one is of the built-up "standard" type, of Brooklyn chrome steel, and was built by the L. H. Miller Safe and Iron Works. The latter vault is 20 feet square by 9 feet in height; its walls are 6 inches in thickness, while its massive doors are 12 inches in thickness. It represents the highest development of the built-up or "standard" vault; and until the introduction of the armor-plate vault, it furnished the best answer that the banks and the trust companies could make to the tools and explosives of the professional cracksman.

It will be evident that the ideal method of construction would be to employ a single plate which combined the necessary hardness, toughness, and thickness all in one, and so do away, at a stroke, with the weakness which is inherent in the built-up construction.

Now these qualities are all combined in the Harveyized armor plate of solid thickness, which is so tough that it cannot be cracked through, so hard that a flake from its carbonized surface will scratch glass like a diamond, and which may be made as much as 24 inches in thickness without impairing any of its other desirable qualities. The introduction of Harveyized armor into vault construction from designs by the Hollar Company, engineers, may fairly be described as the most important single step ever taken in the development of burglar-proof vaults. A vault built of armor plate, with its joints dovetailed together and keyed from the inside of the vault, and provided with a circular door ground into the armor-plate front, is proof against any known method of burglar attack.

It is not necessary for the Scientific American to describe the manufacture of Harveyized armor plate. It is sufficient to say that after the plate has been cast and forged to the necessary thickness, it is covered with a coat of carbonaceous material and heated for several weeks in a furnace until the carbon, which is the hardening element in steel, has eaten down several inches into the body of the plate. The plate is then reduced to size, and the edges where they lock into each other are machined and ground down to the dovetail shapes shown in our engravings representing the system of joining at the corners or angles. After these joints have been machined and ground to an exact fit, the plates are heated and then hardened by subjecting them to a bath of cold water, which is sprayed upon the plates with great force from large mains 12 inches in diameter. The vaults are built with the hardened surface on the outside. The dovetails are formed with one face square and the opposite face cut at the designed angle. The clearances are so arranged that the dovetails slide snugly into place as the plates are drawn together, and after they have been brought home, long wedging strips and key pieces are driven into place from the inside of the vault, locking the plates securely in position. The joint as thus formed is so close and massive that it is proof against any attack by floating nitroglycerine in from the outside, and wedges will make absolutely no impression upon it, the hard face splintering the wedges just as it does the hard point of a projectile. For the same reason the drill is useless; and as for the method of attack by using the arc light and taking the temper out of the steel, it is sufficient to say that the conditions necessary for the use of the arc are so difficult to obtain, that no burglar could hope to use it without detection. The banking public need lose no sleep over the electric arc scare, of which we recently heard so much.

The introduction of armor plate made it possible to use, with the best results, the round or circular door with all the great advantages that it confers. The door itself and its seating in the front plate of the vault are machined to the exact size, and the two are then ground to a perfect fit, in much the same way in which a gas engine valve is seated. The resulting fit is so close that it is not possible to float the most volatile liquid in at the joint, and therefore this favorite point of attack of the cracksman is now perfectly safeguarded.

The armor-plate vault shown in our engraving measures 23 feet by 20½ feet, and is 10 feet in height. It is built of Harveyized nickel-steel armor plates weighing 200 tons. The entrance to the vault is through one of these plates, which is 12½ inches in thickness. The circular door for this entrance is 7 feet 7½ inches in diameter and 13 inches thick, and weighs complete over 16 tons. The hinge is so delicately hung on roller bearings that a child can easily swing the door to and fro. A small round emergency door has been provided in the rear of the vault for ventilation, as well as to guard against the possibility of lock-out through the failure of any of the delicate and intricate time-lock mechanism to operate.

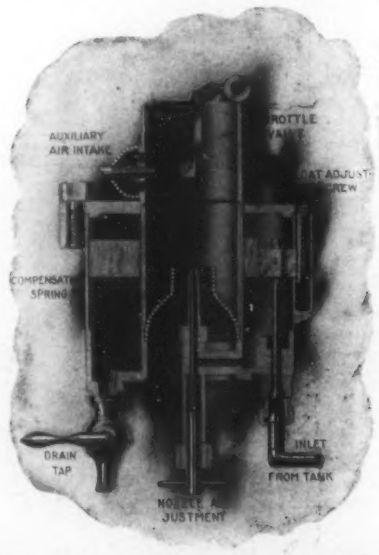
The hinge, compressor, and bolting mechanism was made by the Herring-Hall-Marvin Safe Company. The latter consists of twenty-four 3½-inch diameter cold-rolled steel bolts, which are arranged to slide in and out radially from the center of the door. These locking bolts are moved by a double reserve Yale automatic; this mechanism is in turn checked and controlled by a four-movement electrically-rewinding time lock, which was also manufactured by the Yale Company.

The act of closing the door releases the automatic mechanism which carries the locking bolts into the locked position, and they are retained in this position until the expiration of a predetermined time, when the time lock releases the automatic, which in turn withdraws the bolts, after which the doors may be readily opened. It should be borne in mind that all of the foregoing operations take place without any connection through the doors.

Should conditions arise, however, which would, in the opinion of the proper custodians of the vault, justify them in keeping the vault locked for any additional number of hours, beyond the time for which it was originally set, this can be accomplished without opening the vault doors, and without anyone having access to the locks. The value of this feature may be illustrated when the contingency of fire or riot is considered, for in either case it would be undesirable to permit the action of the timelock mechanism to make possible the unlocking of the vault. Under these conditions, all that would be necessary would be to simply close an electric switch, when the time-lock movements would be electrically rewound, thereby preventing the opening of the doors until the expiration of the added number of hours. Both the Carnegie and Bethlehem Steel Companies are now engaged in the construction of very large vaults of Harveyized nickel-steel armor plate.

AN IMPROVED FORM OF AUTOMATIC CARBURETER.

The annexed longitudinal section shows the interior arrangement of a new automatic carbureter for gasoline engines. The main air pipe is located vertically in the center of the float chamber, and in its center is placed the spraying nozzle with adjustable needle valve, as shown. Surrounding the needle valve is a special, dome-shaped, coiled spring which provides a small opening for the main air supply, and hence produces a strong suction at the nozzle tip when the engine is being started or run at a slow speed. As the throttle valve is opened and the engine speed and suction are increased, the coils of the spring are separated by the augmented suction, thus allowing much of the air to pass directly upward through the coils at the curved or inclined part of the spring. This prevents an increase in the suction at the nozzle tip, which would occur if a larger quantity of air were drawn in a given time through the small opening around the tip, as is the case with most carbureters. Instead of providing suction-operated auxiliary air valves for the purpose of subsequently admitting more air to dilute the richer gas thus obtained at high speeds, Mr. Charles T. Gaither, inventor of the carbureter shown, has carried out the idea of keeping the suction constant at the nozzle, and thus of always maintaining the same mixture, by means of the ingenious arrangement shown. In the carbureter, as at present manufactured, the spring is about 2 inches in diameter at the base, narrowed to ½ inch at the top. It is made of 1-16-inch steel wire, copper-plated to prevent rusting. On account of the large diameter of the spring, a slight spreading of the coils will allow a very considerable quantity of air to pass between them. It may happen that the needle valve must be opened so much, in order to supply sufficient fuel for full power at high speed, that too much gasoline is drawn at low speed. This can be regulated by opening the auxiliary air inlet the right amount, or until a perfect mixture is obtained at low speed. Thus there are two adjustments, the needle valve and the auxiliary air intake, for accommodating the mixture to the compensating spring. The auxiliary air intake, also, is made up of a dome-shaped coiled spring, the coils of which are separated enough to let pass the requisite auxiliary air by simply unscrewing a stud set in the wall of the vertical main air pipe. This pipe is surrounded by a cork float pivoted upon a vertically-adjustable pin in the wall of the carbureter, by means of which it is possible to set the float so that it will close the conical supply valve at any desired point and thus maintain the fuel level nearer or farther away from the tip of the spraying nozzle. This is an adjustment that is not absolutely necessary, but which nevertheless is sometimes found useful.



SECTION OF A NOVEL AUTOMATIC CARBURETER.

The ordinary form of automatic carbureter, of which the Krebs (illustrated in our February 14, 1903, issue) was the prototype, has some form of auxiliary air valve placed between the spraying nozzle and the inlet pipe of the motor in about the position of the auxiliary air intake shown in the cut. As the suction increases, this auxiliary air valve is opened, thus tending to diminish the suction past the spraying nozzle, so that it remains nearly constant and, at the same time, to dilute the relatively rich mixture that may be at first obtained when the throttle is suddenly opened.

An appreciable period of time is taken for the mixture to become correct again, if, when the motor is running throttled, the throttle valve is suddenly thrown wide open. The result is that with most of the automatic carbureters there is an appreciable lag before the motor responds. With the Gaither carbureter, however, this lag is practically *nil*, and the motor seems to respond instantly when the throttle is opened. The reason for this is doubtless the location of the suction-controlling device at the spraying nozzle, so that the mixture is maintained uniform as it is formed.

Starting of the motor is easily effected with this carbureter, as several fine holes on the inclined sides of the tip spray gasoline upon the inside of the coiled spring when the carbureter is primed, and the fuel, trickling down over the corrugated surface, is readily drawn by the inrushing air when the motor aspires.

A Wonderful Lock.

Mr. Neuman Tobias, of Kingston, Jamaica, has invented a most remarkable lock. The combination consists of four sets of 24 letters of the alphabet, which can be set to a sentence in most modern languages. When one letter is used in one alphabet and another in the second set, and so on, it becomes a very complicated matter indeed. Then there is the initial problem of what language it has been keyed in, to be solved by the man who attempts to open the safe. Furthermore, instead of letters, Mr. Tobias has employed four sets of numerals. Assuming that the lock is set to a figure in the number of 3,030,303,030,303,030, it would take anyone who undertook the job of unlocking the safe 96,090,278 years, 269 days, 30 minutes, and 30 seconds working at the rate of 60 numbers a minute to arrive at the proper "combination." During this time he would have no time for eating, drinking, or sleeping.

The Current Supplement.

The current Supplement, No. 1581, is begun by Enos Brown with an article on a new type of bascule bridge which has been erected in San Francisco. Concrete Aggregates is a subject which Mr. Sanford E. Thompson discusses from the practical standpoint. James P. Maginnis continues his monograph on reservoir, fountain, and stylographic pens. Practical methods of waterproofing and fireproofing are given. Julius Wile writes on gas producers for power, and gives some telling arguments why producer gas should be used for certain purposes. Lightning and the electricity of the air will be discussed in a series of articles by Alexander G. McAdie. The first of these articles appears in the current Supplement. Louis A. Fischer concludes his history of the standard weights and measures of the United States.

The celebration of the first settlement of America at Jamestown will take place in 1907. The navies of the United States and foreign countries will be in Hampton Roads, and representatives of the armies will assemble upon the adjoining land near Fortress Monroe, Va. At the same time, in connection with the State of Virginia, the city of Norfolk, assisted by the different States of the Union, will hold a great historical and industrial exposition along new lines, out of the beaten track of previous expositions. A striking new feature that seems to be of more than ordinary interest to our readers is the proposed erection of a special building to be known as the Hall of Modern Inventions.

Correspondence.

A Mercury Photometer.

To the Editor of the SCIENTIFIC AMERICAN:

I have been very much interested in the articles published in your journal on standards of light and standard photometers. Several years ago I conceived the idea of such an instrument, which I called a mercury photometer, and which was made in a manner not unlike the ordinary thermometer, using, however, an electric circuit and a selenium cell. The following is a detailed description of this instrument:

It is necessary to provide a frame similar to the ordinary thermometer frame, but deep enough at the back to receive a small dry battery, and having room at the top for a selenium cell. The battery is connected to the selenium cell, and in front of the latter is placed a finely-ground glass plate, to diffuse the light evenly and to protect the cell from undue excitation. The cells are connected by a filament or a thin platinum wire, which passes through the mercury bulb of the thermometer column, and thus the temperature of this filament affects the expansion of the mercury and, consequently, the height of the mercury column in the thermometer. The filament might be covered with a very thin sheet of asbestos, just sufficiently thick to insulate it from the mercury, and with this covering is fused into the mercury bulb. The current strength would be governed by the selenium cell, and would be proportionate to the amount of light falling upon the latter through the ground glass. Thus the height of the column of mercury, in accordance with the amount of heat given off by the platinum filament, which in turn is proportional to the amount of light falling on the selenium cell, would be in direct proportion with this degree of light.

To allow for the rise of the mercury due to the local temperature conditions, a sliding scale might be provided alongside the tube, which could be used in the following manner: Suppose the local temperature to be 70 degrees. This temperature is noted, and the zero point of the sliding photometer scale is placed at this point of an ordinary Fahrenheit scale, with which the frame is also provided, then the units of light may be read directly from this sliding scale between the point 70 on the Fahrenheit scale and the top of the mercury column. If the ground glass is covered and no light is admitted to the selenium cell, the mercury column will merely register the ordinary temperature, and thus, if a cover be provided to exclude the light from the glass, the temperature can be determined by keeping this cover closed. Besides this a switch could be provided for throwing the current in or out to answer the same purpose.

The upper limit of the rising of the mercury column would have to be in the neighborhood of 600 deg. F., as the point of vaporization of quicksilver is about 662 deg. The photometer scale should be divided into 100 parts, starting from zero or absolute darkness. Various lights, such as a good reading light, light too bright for the eyes, etc., could be indicated on this scale, and thus the instrument would become invaluable in the school room. JOSEPH BREVAR.

Cleveland, O., March 10, 1906.

An Object Lesson in Aeronautics.

To the Editor of the SCIENTIFIC AMERICAN:

The fate of Paul Nocquet, who made an ascension with a coal-gas balloon Tuesday evening, April 3, 1906, from 135th Street, New York, landed about 10 o'clock the same evening near the life-saving station at Jones's Beach, Long Island, and then wandered two miles away through a swamp to his death by cold and exhaustion at Cott's Island in Bass Creek, is a valuable and instructive example of things one ought not to do.

Daring is not a prerequisite in ballooning or automobiling, and recklessness is homicidal in any walk of life. Paul Nocquet's first imprudence was a night ascension at an inclement season of the year, no more suitable for ballooning than is a sloppy spring road in the country for automobiling. His final mistake, after wandering in darkness and space above, consisted in leaving the safe location of his landed balloon and wandering in darkness and space below. The risk on earth seems greater than above, though both could have been avoided by an earlier trip by day. Surely the fate of Paul Nocquet is not an example of the inherent dangers of air journeying.

I take some credit to myself for having indulged in this pastime during thirty summers without harm to myself, and for having managed thousands of hydrogen-gas balloon and airship ascents by other persons, aeronauts, and the unskilled public, without harm to any. This large experience must have a certain value in the critical diagnosis of the symptoms of the present ballooning epidemic.

I have steadfastly disapproved of motiveless night ascensions at inclement seasons.

Prof. Wise, the veteran survivor of 1,200 gas-balloon voyages, and the pioneer long-distance aeronaut who traveled 1,200 miles in 19 hours forty-five years ago, finally lost his life on a stormy night in company with young Burr, a St. Louis banker, who wanted a night ascension. They probably met their fate in a Michigan swamp or a Canadian wilderness that night.

Aeronaut Donaldson with Reporter Grimwood met death through similar causes, starting from Chicago in a storm across Lake Michigan which wrecked forty vessels that night. After this a long interval elapsed without any fatality with coal-gas balloons in America. There has never been a fatality during any hydrogen-gas balloon ascension throughout America.

Compared with any other means of transportation, the aerial line seems miraculously safe. Yet there is no magic in it. One should have good weather, good apparatus, good gas, and good common sense, both in the air and on landing. Among all ascensions under my charge, the rule of sticking to the vessel was only broken once, by a reformed hot-air balloonist, who made a first hydrogen-gas ascension with my balloon, and on landing, let it fly. I traced this balloon from Willimantic, Ct., to the Atlantic coast, where it took a trip over sea, and returned next day, and was recovered in perfect condition near Newport, R. I. This led to my investigating sea breezes, which blew low toward the land, and generally seaward higher up. As a result of this, various balloon flights were made from the Atlantic coast, returning safely to land by the lower current. It is perfectly in line with this experience that the Nocquet balloon should float over sea on the higher current, and draw inland with the lower, landward wind.

I have some curiosity now to learn if the tide was also flowing inland when the Nocquet balloon came ashore. No scientific records exist of night voyages in cold weather on our coast. I strongly disapprove of such attempts. Neither can I see pleasure in them. They have no excuse as "sport."

The record of cold-weather ballooning began this year with an ascent from West Point, a 40-mile trip, amid winter rigors, to a landing in darkness, facing unknown dangers. Next an ascent from Tuxedo, late, with poor gas, no ballast, and a brief rise and fall. Following this was an attempted balloon race from Pittsfield, Mass., resulting in the destruction of one balloon and the escape of the other in the fierce March winds. Next the 20-minute flight of Count de la Vaulx, ending with a skillful beach landing. Next the adventurous death of Paul Nocquet.

What a record is this to repress ambitious aspirations to ride the wind! I earnestly protest that this is neither science nor sport. It is simply inopportune haste to "rush the season." "Wait till the clouds roll by," and balmy airs and sunny skies invite a visit and a pleasant loiter along the heights where "distance lends enchantment to the view," which literally "beggars description." Then harness up your balloon car, and start early from some safe inland point, whence you may sail all day and picnic in midair. This is ballooning, and I will stake my reputation on its success and safety. CARL E. MYERS.

Balloon Farm, Frankfort, N. Y.

A Strange Cargo.

One of the strangest cargoes a vessel could possibly have was unloaded at the London docks toward the close of March. It consisted of several sacks filled with dried flies, consigned to a large firm of grain merchants. These flies, originating in Brazil, have been purchased for use in the manufacture of food for chickens, cage birds, and the like. They were caught on the river Amazon by Brazilians, who travel up the river in flatbottomed boats, and who are provided with gauze nets, with which they capture these insects in millions, as flies hover in dense clouds over many of the swampy reaches of the Amazon.

The flies thus caught are killed, dried in the sun, and then placed in sacks. Upon arrival in London they are mixed with millet and other grain, and are sold as chicken food, etc. Some time ago the Brazilian government, fearing that the fish in the Amazon River would be starved, forbade the exportation of flies; hence the price of this strange commodity, which used to be 6d. per pound, has now risen to 1s. 6d. per pound, and often a little more.

Constitution and Properties of Aluminium Steels.

Aluminium steels have been studied by M. Osmond and M. Hadfield. M. Hadfield has shown that the malleability ceases at about 5.6 per cent of aluminium, and that the elongations commence to lower at 1.5 per cent. M. Osmond has shown that steels containing 5 per cent of aluminium no longer present the point of transformation A_3.

Resuming the study of these alloys by the same method as that employed for other special ternary steels, M. Guillet has been able to establish the constitution of these alloys and the bond which unites their mechanical properties. These experiments are said to show that aluminium has no important action on the mechanical properties of steel so long as quantity is less than 2 per cent. Up to 15 per cent aluminium is dissolved in iron. The ferro-aluminium solution thus formed does not dissolve carbon; so perlite takes a granular form, which explains the fragility of certain steels; martensite is produced by tempering only where there is no perlite. Finally, free martensite is found in steels with high percentage of aluminium, although these steels contain less than 0.850 per cent of carbon.

The Maternal Love of Spiders.

It is not unusual to find, in fields of oats, panicles which are more or less enveloped in spiders' threads crossing in every direction, so as to form whitish nodules the size of pigeons' eggs, and inclosing in their tissue the spikelets, and sometimes the leaves of the grain. These are the nests of a spider, the *Chiracanthium carnifex*, which is of a yellowish gray color with a brownish band on the dorsal face of the abdomen.

Upon opening one of these nests, it is seen that the interior is hollow and that only a small part of the cavity is occupied by the eggs and the mother. The former are in a little spherical cocoon, formed of silk like the side of the nest to which it is securely attached, while the female which has laid the eggs remains within the nest; she is often found resting on the cocoon itself, but sometimes leaves that place. When an opening is made in the wall, she goes to see what has happened, and may even go outside, but she hastens back, and immediately begins to weave a tissue to mend the breach in the nest. Her love for the cocoon is manifest, for she never abandons it even when tormented.

How far-reaching this maternal love is, and its duration, is the question which Mons. A. Lecaillon has attempted to solve by removing the true mother of each nest and giving her place to a stranger, which we shall call the "pseudo-mother." Some of his experiments have all the interest of a little drama.

After having made a break in the web of the nest, the mother is removed and her place is given to a pseudo-mother. She enters it without hesitation, takes a survey of the interior, and at once begins to close the entrance. The mother is then brought to the nest. She goes toward the entrance and wishes to penetrate it, but stops on finding the place occupied. The pseudo-mother, who cannot come out while her adversary remains at the entrance, seeks to defend herself against the attack with which she is threatened, and puts herself on the defensive. The mother then shows signs of violent anger. She rocks her body from right to left and from left to right, and the two spiders exchange blows through the opening.

The mother's attitude is violently offensive, menacing to seize her adversary, while that of the pseudo-mother—who cannot come out to save herself, since the opening is besieged—is one of fear and only defensive; she is conscious that she is not at home. Twice the besieger leaves the entrance to find some other place to penetrate into the nest. Her opponent then attempts each time to jump across the opening to save herself, but the mother, seeing this, immediately returns to seize her. The pseudo-mother, not entirely out of the nest, has only time to throw herself back, and finally, the mother having withdrawn the third time, she is enabled by a quick movement to escape, although the former again advances, but cannot seize her.

The attack of the nest by the mother continues a quarter of an hour. Then, after having spent several seconds in assuring herself that her rival has disappeared, she enters, but comes out two successive times in order to again explore the exterior. Finally she returns and, after remaining immovable for five minutes, begins to stop up the aperture. The pseudo-mother is placed upon the nest three times, but refuses positively to approach from the side, and retreats precipitately.

This experiment shows that the pseudo-mother readily adopts another nest, even when she has been separated from her own several days, but does not defend it against the attack of the mother. When the latter is in the nest, she refuses to try to enter. The mother, on the contrary, does not hesitate to besiege her enemy until she overpowers her and regains possession of the nest.

The experiment is repeated after the mother has been kept from her nest twenty-four hours, and it has been found that she shows great attachment to it, with a desire to again gain possession. But, at the same time, the pseudo-mother has become attached to her nest of adoption, not leaving it voluntarily, and even defending it vigorously from the attack of the true mother.

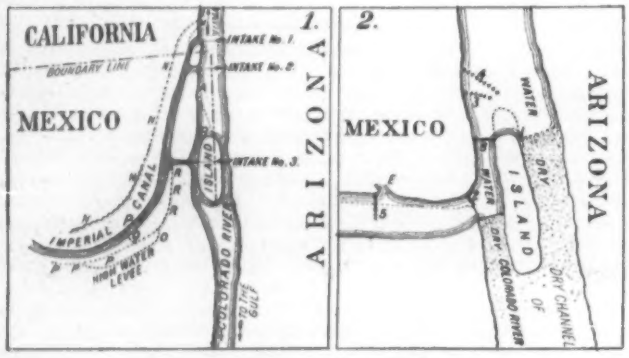
When the mother had been kept from the nest eight days, she did not show any interest in her eggs, nor try to recover them when placed in the vicinity.

Maternal love among the spiders which have been studied is therefore very manifest, but it diminishes when the mother is kept away, and finally disappears. How similar are human sentiments under like conditions!—Translated from La Nature.

THE OVERFLOW OF THE COLORADO RIVER AND THE SALTON SEA.—II.

BY GEORGE WHARTON JAMES.

In last week's SCIENTIFIC AMERICAN it was briefly shown what efforts had been made to close the "temporary expedient" cut of the Colorado bank below Yuma at the point known as the third or lower intake.



Diagrams Showing Location of Intakes.

The accompanying diagram will give the location of the intakes. Intake No. 1 is where the old headgate was placed, which soon became choked up with detritus and was used only during high water, as at low water it was some four or five feet below water level. Intake No. 2 was cut on the Mexican side of the boundary, to conform with a provision of the Mexican charter to the irrigation company. It was practically unused. Intake No. 3 is the "temporary cut" which has caused all the trouble, and which was made because it was cheaper than dredging out intake No. 1. It was the intention of Chief Engineer Rockwood, when this cut was made, to place therein, as speedily as funds would allow, the necessary headgate required, so that this would have become the permanent intake, properly under control, required by the Mexican concession. It was also his intention, constantly expressed, to construct a permanent and sufficient headgate at or near intake No. 1; and, as will be seen shortly, these two are the major propositions upon which the company is now vigorously working.

When work on closing up Intake No. 3 began in May, 1905, the cut was about 100 feet in width. When the water subsided it had grown to 500 feet in width, and was still carrying about 14,000 cubic feet of water per second, with a depth at one point of 24 feet.

On July 18 the Yuma gage showed 121.8 feet, with 18,000 cubic feet flowing through the intake, and only 7,000 passing down the old river channel to the Gulf.

A new attempt was now to be made to control the water. A site was chosen a mile above the former one. By reference to the diagram, it will be seen that an island divides the Colorado River channel opposite intake 3. This island is about 3,000 feet long by 1,200 feet wide. The plan now proposed was to construct a light jetty of piling and brush, beginning at a point on the Mexican side marked *A*, and continuing to a point on this island marked *B*. The idea in this effort was to control the river by the formation of a sand bar behind the brush, thereby diverting the main portion of the flow to the Arizona or eastern channel of the island. The experiment failed. In the meantime preparations were under way for a more ambitious undertaking. In August materials were ordered for the new attempt. This involved the construction of a gate at intake 3 large enough to pass the entire flow of the river at low stage, after building which it was the intention to construct a permanent dam across the rapidly widening "cut." When this dam was secure the gate would have been closed, thus raising the water and throwing it down the old channel. This gate it was proposed to make the one required by the Mexican government. The floor was to be of concrete three feet in thickness on a pile foundation. The superstructure was to be of wood temporarily, but ultimately to be replaced by concrete.

A two-yard dipper dredge was at once set to work excavating a big channel to carry the water around the gate site, as marked *E* on diagram 2, and the steamer ran around this pass while work on the dam progressed. This consisted of piles driven at the point marked 5 on Diagram 2. These were taken completely across the channel, capped, and a runway built on them from one side to the other. The steamer hauled gravel for a week to make a bottom around the piling, and the cutting of 150 tons of brush for the fascines was rapidly proceeding. All the material was on the ground for the new structure, and it seemed on a fair way to be successful, when orders came from headquarters to stop the work. The water was rising so rapidly at Salton that some other expedient must be tried at once requiring less time, and thereby saving the complete washing away of the railway tracks.

The Southern Pacific engineers proposed the construction of a pile dam across the west channel, near the head of the island at the point marked 6 on Diagram 2 in order to force the water down the east channel. The west channel was here 650 feet wide and about 10 feet in maximum depth. A dam was to be built of woven wire cable mats, filled in with bundles of brush and barbed wire anchored in the river with piling. When completed it would have to withstand a water pressure of 16 feet. Work was begun in the middle of the channel, and with two pile-drivers and a large force of men rushed as much as possible. All progressed favorably until the piling and mats reached within a hundred feet of the shore on both sides. As the work was nearing completion water was raised in the old river channel on the west side fully 14 inches. No matter how much weight was put on the mats to prevent scouring, the water would get under them and cut away the channel. The island, on which all hopes depended, began to wash away. On the 29th of November the severest flood since February, 1891, swept down the river with resistless force, and carried away a portion of the work and much of the equipment. The island was completely flooded, and 240 workmen, 13 wagons, a carload of hay, another of provisions, and 38 head of horses had to be transferred to a barge instanter, or they, too, would have been swept away.

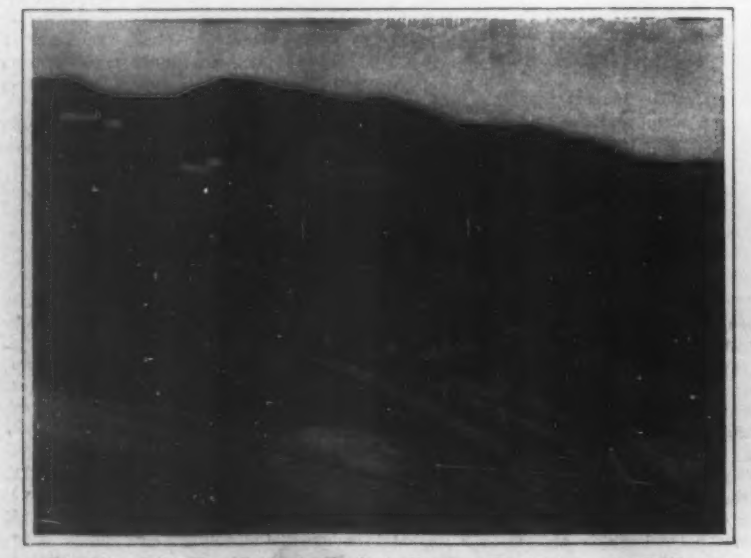
This was the last effort prior to the one upon which work is now progressing. The present plan is to construct a permanent headgate at point marked *M* on Diagram 1. This is four miles up the river from the lower intake, and on the United States side of the boundary. The anchoring foundation is solid rock, and the structure is to be of reinforced concrete. It will be 185 feet wide and 26 feet high above the sill. The floor is to be placed 11 feet below the low-water mark and 4 feet below the river's bed. It will have 154 feet of water openings, and at the lowest water stage of the river can pass 7,000 cubic feet per second.

It will be composed of twelve reinforced concrete cells about 16 feet wide by 14 feet high. These will be filled with rock, gravel, and sand, which will be fully ample to make the structure stable, so that it will withstand the pressure of the heavy floods.

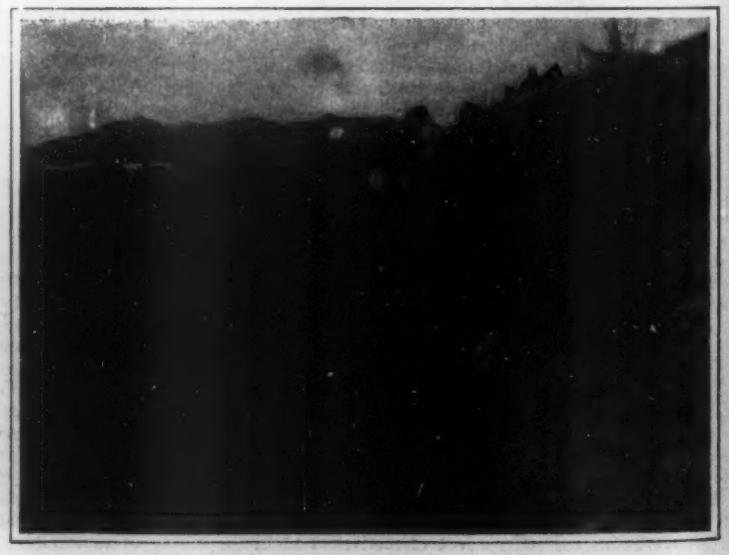
On March 20 the excavations were all completed, and the concrete work actually begun. This gate will carry 7,000 feet of water per second, while the flow of the Colorado at low water is only about 5,000 feet, and sometimes as low as 3,500 feet per second. The building of this gate implies the widening and deepening of the old canal, which is but 80 feet wide, and at low water can carry but two feet in depth. This is to be enlarged to 170 feet wide and 11 feet deep (see dotted line *N*, Diagram 1.) below low water. This work involves the excavation of 1,800,000 yards of earth.

The permanent work at intake 3 is resumed near the point where it was abandoned last year (Diagram 1, *P*) with the necessary enlargements and alterations caused by the changes brought about in the interval by the power of the stream. From 300 feet in width it has grown to over 650 feet. (See dotted line in Diagram 1, marked *R R*). The floor of the new gate will be 200 feet wide and 60 feet long. It will be placed 11 feet below the extreme low-water level in a quicksand formation, and anchored to 533 foundation piles. Aprons 30 feet in length extend from the floor

Cofferdam at the Site of Headgate No. 2.



The Site of the New Concrete Headgate No. 1 at Hanlon's on the California Side of the Boundary.



One Year's Growth of Willows in the Silted-up Canal Bed, Showing the Fertility of the Soil.

to the coffer-dam wall, and wings 100 feet in length extend up and down the stream. Nearly 600,000 feet of lumber, including 1,680 lineal feet of sheet piling wall, 6 inches thick, driven from 12 to 22 feet, will be used in its construction and protective works. Eight hundred and fifteen round piles will be used in the foundations, wings, and diversion jetty.

The earthwork in the approaches to the gate involves the moving of 120,000 cubic yards of earth in excavation an average distance of 350 feet, and the fill in the diversion dam and levees contains 59,600 cubic yards of earth, 2,000 cubic yards of brush, and 20,000 grain sacks filled with gravel.

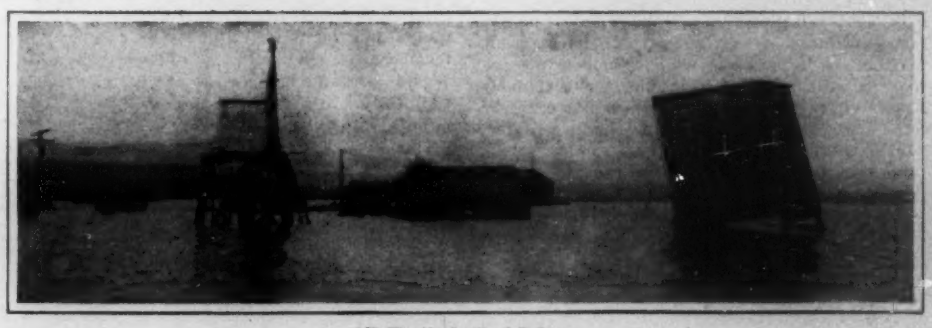
It was decided on the 17th of December, 1905, to resume this work. New material had to be ordered, as all the original supply had been removed to carry on the work which the November flood had destroyed. On the 8th of January, 1906, work on the walls of the coffer-dam began. This is 250 x 120 feet, and contains 740 sheet piles 6 x 12 inches, 22 feet long. It was completed and the earth within excavated on the 15th of February. An 8-inch and a 6-inch centrifugal pump were set to work, and lowered the water as far as was necessary in two days' time. The 8-inch pump now keeps it at a proper level. A force of 160 men is at work here now, day and night. As soon as water can be turned into this gate, a permanent dam will be constructed across the channel slightly below the point marked 5 on Diagram 2.

Levee Built Parallel with the South Branch of the Alamo River Near Headgate No. 2 to Stem the High Water.

Two-Yard Dipper Dredge at Work at Headgate No. 2.

It should not be forgotten that fifty miles away from the Colorado the engineers are battling with another problem caused by the overflow. At Sharp's, seven miles southeast of Calexico, is the point of diversion, where the water from the main canal (which, it should be remembered, is the bed of the old river Alamo, dry except in time of flood) is taken, and by means of canals, all of which are controlled by headgates, is supplied to the various sections of the Imperial country. When the flood began to pour down the Alamo, the result was to scour out and deepen the channels around the heading at Sharp's. This scouring still continues, and will continue, so long as the flood is allowed free course.

The old waste headgate was found insufficient for flood purposes, and a new and large structure was erected. But the unusual flow began to undermine the new gate by the cutting back of the channel under the fall. It was necessary therefore to close this gate to save it, and construct an apron to protect the channel below the fall, and, therefore, the abandoned headgate had to be put into commission again. An emergency chute was attached to it in February, 1906, with a flume 28 feet wide and 6 feet deep, and through which 1,300 cubic feet of water is flowing to waste every second. This waste flow is rapidly cutting down the channel to the depth already of some 18 to 20 feet.



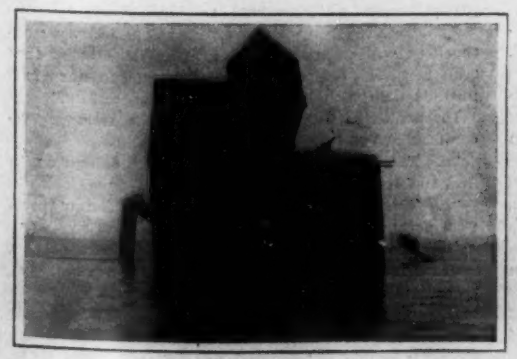
All That's Left of Salton.

The Salton Salt Works Now Under Water.

Work on the apron on the new waste gate is rapidly progressing, however, when water will be turned therein, the old gate closed, and a restraining jetty built across the old channel, so that the full flow will be under complete control.

Of the Salton Sea it can now definitely be said that its new life will not be long. Not that it will entirely disappear. This is scarcely to be expected. The seepage and drainage from so large an area as the Imperial Valley under irrigation will necessarily be large. This will undoubtedly keep the sea at a certain level. What that will be has not yet been, and scarcely can be determined, though it is certain it must be several feet, probably many, below the present level.

Switzerland is likely to furnish a supply of asbestos for the trade, if we are to believe the most recent reports, which state that important layers of asbestos have been recently found in the Puschlav Valley, which is located in the Canton of Grisons. A syndicate has been formed already, in order to work these deposits. At the same time the syndicate proposes to construct a line of electric road which will connect the mine with the railroad station of Tirano and thus give a quick means of transporting the material. One of the principal Swiss firms which are interested in the enterprise is the house of Victor Schneider, of Geneva.



A Reminder of the Ruined Salt Industry.

Pile Dam Built Partially Across the Colorado to Force the Water Down the Silted-up Canal.

THE OVERFLOW OF THE COLORADO RIVER AND THE SALTON SEA.—II.

VESUVIUS: PAST AND PRESENT.

Because of its constantly recurring outbursts, Vesuvius has been more carefully watched than perhaps any other of the world's volcanoes. Delicate instruments have been devised to foretell an eruption, and it is no doubt due to these that the crater's present activity has cost only hundreds and not thousands of lives. And yet we can no more account for the slumber of Vesuvius than for its violent outbursts. Even constant observation has not always enabled science to forecast the occurrence of the upheavals. During the great eruption of 1872, Prof. Palmieri's delicate seismographic instruments at the Monte di Somma observatory gave not even the slightest indication of what was to come; and so while we are familiar with the record of the past, that of the future is often veiled.

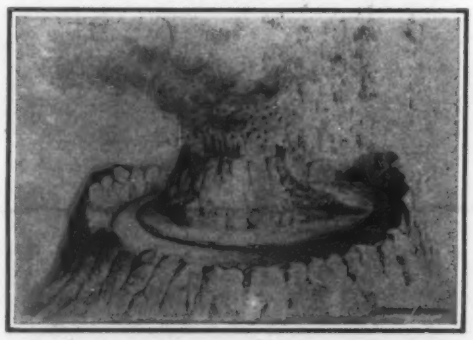
Although there were vague legends among the ancients concerning the fiery nature of the mountain, it was not till the year 79 that the true character of the great solitary cone rising from the plain of Campania was suspected, notwithstanding that sixteen years previous, in 63, and repeatedly thereafter, severe earthquakes partially destroyed the cities in the vicinity of the Bay of Naples. From the geographer Strabo we learn that the slopes of Vesuvius were at that time covered with fertile meadows, though the summit, which was flat and apparently without traces of a crater, was sterile and showed indications of a fiery origin. Almost without warning on August 24, 79, an enormous cloud of black vapor rose from the summit accompanied by the explosion which shattered the top and marked the beginning of the great historic eruption so ably described in the letters written to Tacitus by Pliny the younger, nephew of the famous Roman admiral of that name, who perished while hastening to the relief of the inhabitants of Pompeii, Herculaneum, and Stabiæ with the fleet under his command. Pompeii was overwhelmed and buried to a depth of many feet by a terrific rain of volcanic ashes. We can only estimate the number of the inhabitants who perished, but the mode of death is indelibly recorded in the molds of bodies found in the ashes of the dead city by the excavators of to-day. Herculaneum, on the other hand, was destroyed, not by a great flow of lava, as is commonly believed, but by torrents of boiling mud formed in the air by the condensation of great masses of vapor laden with lapilli or scoriæ, as the volcanic sand or ashes are known.

The first eruption definitely recorded after this was described by Dion Cassius. It occurred in 203, and appears to have been one of extraordinary violence. In 472 the mountain burst forth again in a terrible upheaval, during which it was said that clouds of ashes were carried as far as Constantinople. In the period between the first outburst and the year 1500 nine eruptions of greater or less intensity were recorded, while between 1500 and 1631 Vesuvius was entirely quiescent. So deep was the mountain's slumber during this time that it again became covered with vegetation and cattle peacefully grazed in the crater. Strangely enough, during this period Etna labored ceaselessly, and Monte Nuova was formed by an eruption near Pozzuoli. The lull was broken by a terrific outburst, the first of which we have a detailed account, on December 16, 1631, when huge clouds of vapor, violent earthquakes, showers of ashes and rocks, and no less than seven great streams of lava overwhelmed five of the neighboring towns, with a loss of thousands of lives, and even spread terror in Naples itself. This tremendous convulsion inscribed its memorials on the slopes of the mountain in obliterated estates and ruined villages. It appears that Vesuvius did not assume its present form until near the end of the seventeenth century, for Sorrentino describes an eruption of 1685, during which there arose "a new mountain within and higher than the old one and visible from Naples." Thus it seems that the present Monte di Somma is really the original Vesuvius, and that the present cone is little more than two centuries old. From May to August, 1707, a continuous series of eruptions involving the loss of some three thousand lives again devastated the vicinity, and in 1737, 1760, and particularly in 1767, Vesuvius repeatedly manifested activity of a terrific nature. In one of the accompanying illustrations is shown a sketch made by Sir William Hamilton before the great eruption of 1767, in which there appear to be three craters, one within the other, the outer of which is Monte di Somma, and the second the present cone of Vesuvius.

A stupendous eruption took place in 1779 during which huge red-hot stones were hurled to a height of over 2,000 feet. The eruption of 1794 was even more terrible in its effects and was remarkable for the vast streams of lava which were precipitated into the sea near Torre del Greco. During the nineteenth century volcanic outbursts of remarkable violence occurred in 1804, 1805, 1822, 1831, 1850, 1855, and 1858. During the last-mentioned the upper crater sank several hundred feet below its former elevation. In 1861 another exceptionally violent outbreak occurred which again devastated Torre del Greco.

After a decade of comparative quiescence the mountain inaugurated a new series of outbursts by the emission of a number of small streams of lava in January, 1871, a series which culminated in 1872 in the tremendous eruption of that year. The greatest intensity was manifested from the 24th to the 30th of April, and during this period great streams of lava burst forth from all sides of the slope. One of these issued with such suddenness at the Atrio del Cavallo—the valley between the cone and Monte di Somma—that it overtook and destroyed a number of persons out of a crowd of spectators. At the same time the crater vomited great masses of vapor, stones, and lava to a height of over 4,000 feet, while clouds of ashes rose double this distance into the air. Such was the violence of this great eruption that it seemed as if the gigantic tragedy of 79 were about to be re-enacted, for several of the great molten rivers even threatened to reach the walls of Naples itself, while the storm of ashes and red-hot stones appeared almost inexhaustible. Until 1895, Vesuvius remained in a fairly quiet condition, but in that year a violent eruption took place, accompanied by a flow of lava which continued to advance for a number of years, but fortunately did not directly threaten any of the neighboring towns or villages.

The present eruption is unquestionably one of the most violent of modern times and already has shown itself to be of a most destructive nature. The flow of lava has not been of remarkable magnitude, though this, too, has caused enormous damage; but the fall of lapilli and stones has been almost unprecedented. The danger due to the latter is the more pressing one, and the great loss of life can be laid at its door alone, for the people, terror-stricken by the violence of the volcanic detonations and the murky yellow gloom, huddle together in buildings, many of which collapse under the weight of the accumulated material which has fallen upon them. Even in Naples itself this danger has been followed by fatal results, for the direction of the wind, not as in former eruptions, has been steadily toward



Sketch of the Crater of Vesuvius by Sir W. Hamilton Prior to the Eruption of 1767.

the crowded city. The darkness which has enshrouded the vicinity for days has been so deep that it was not possible for vessels to enter or leave the harbor, and it has at times raised the terror of the thousands of homeless refugees to a pitch bordering on frenzy. The communities lying on the slopes of the mountain have naturally suffered most severely, and entire towns have been wiped out with heavy loss of life, while miles of fertile, blossoming farms and vineyards have been converted into a desert of smoking gray ashes. Astonishing as it may seem, the seismographic observatory on Monte di Somma again appears to have escaped the general destruction which involved the railway up the mountain and the rest houses. This is probably due to the foresight of the founder, who placed it on a solid rock ridge and in such a situation with regard to the natural courses of the lava streams that its only probable peril arose from the fall of volcanic bombs and ashes. During the eruption of 1872 Prof. Palmieri remained at the observatory the entire time. Toward the end of the convulsion two streams of lava coursed down ravines on each side of the building, and notwithstanding that all the doors and windows were tightly closed, the temperature within rose to 178 degrees, causing the inmates to suffer terribly. Prof. Mattucci, the present director, has also remained at the observatory during the present eruption, and notwithstanding great suffering and the destruction of many of the delicate instruments, has probably succeeded in recording many valuable observations.

It appears that during this eruption great changes have again been wrought in the form of the mountain, and it will probably be found when the crest is once more visible, that as in the great eruption of 79 the major portion of the top has been completely blown away to be rebuilt in succeeding years by the slow welling forth of lava and ashes. After the first great historic outburst, Vesuvius never regained its original appearance, and a remnant of the broken wall of the crater valley which crowned the older summit is still visible in Monte di Somma. During some eruptions the mountain has increased in height and during others it has sunk hundreds of feet. This alternate rising and falling of the top is a portentous feature of the history of Vesuvius and is indicative of the constant state of unrest in which the mountain has labored since the beginning of the Christian era.

That there is nothing within the range of human knowledge which possesses greater power to compel sheer terror—more psychological than physical, perhaps—and abjectly helpless fear in the mind of man than a violent volcanic eruption, is undeniable. But either the exigencies of life or some peculiarly fatuous mental characteristic brings back to the very shadow of the great destructive agency those who fled in panic from their doomed habitations. There is no better example of this curious, careless attitude than the town of Torre del Greco, four and a half miles from the foot of the mountain, which has been overwhelmed no less than seventeen times. Incredible as it may seem, Martinique and St. Vincent, in the West Indies, the scenes of almost unparalleled devastations, which involved the loss of nearly half a hundred thousand lives, are being re-peopled; and doubtless as soon as Vesuvius, metaphorically, droops the lid of its fiery eye once more, we shall see the Italians returning to the ruins of their homes to repair by years of work the destruction caused in as many minutes, and to again populate the scores of little towns and villages, trusting to their numerous patron saints to avert such disasters in the future.

The Need of Medical Men in the Claim Department of Railroads.

According to Dr. Marcus H. Thomas, who points out the importance to the railroads of first aid to the injured, both from a humane and economic standpoint, in the January 6 issue of the Journal of the American Medical Association, the railway accident, in spite of modern inventions and appliances, is not only apparently inevitable, but on the increase. Among the 1,300,000 persons engaged in operating the railroads in the United States, statistics show that one in each 500 was killed during 1904, and one in every 24 was injured. Taking up the consideration of the subject from the standpoint of sordid advantage, "the one which should be of paramount importance to the railroad, with whom the economic question is always one of vital interest," the author says:

"The steam railroads of the United States pay annually in damages to injured persons 0.74 per cent of their gross earnings. This is seemingly a trifling decimal, but in coin and currency it amounts approximately to $14,000,000. In addition to this sum, $1,000,000 is spent annually in the maintenance of a legal department, one-half of which expense may safely be attributed to the defense and settlement of personal injury damage suits. These figures do not cover the total expense of injuries by common carriers by any means. This compilation pertains solely to the steam railroads, while the interurban electric lines and local street railway lines increase the above totals many fold. Particularly do the local street railways add enormously to the list. It is estimated that the Metropolitan Elevated of New York alone pays annually $2,000,000 for personal injuries, and has constantly on hand nearly six thousand suits of this nature. The Brooklyn Rapid Transit Company's annual personal injury budget is in the neighborhood of $1,000,000. The ease with which evidence can be purchased, and the ubiquity of the professional damage suit lawyer in the large centers of population, gives the simulator and impostor a larger percentage of successful chances than with the transcontinental railroad."

Dr. Thomas contends that the surgeon who is qualified in the negligence law is in a position to render the most effective and economic service as adjuster of personal injury claims.

"There exists to-day," says he, "in most of otherwise well-organized railroads a lack of co-ordination between the legal and surgical staffs, as a result of the one failing to grasp the importance of the technic of the other. This proposition operates with equal force conversely. It is into this breach that the medico-legal claim adjuster can step to the assistance of both departments and with economy to the company."

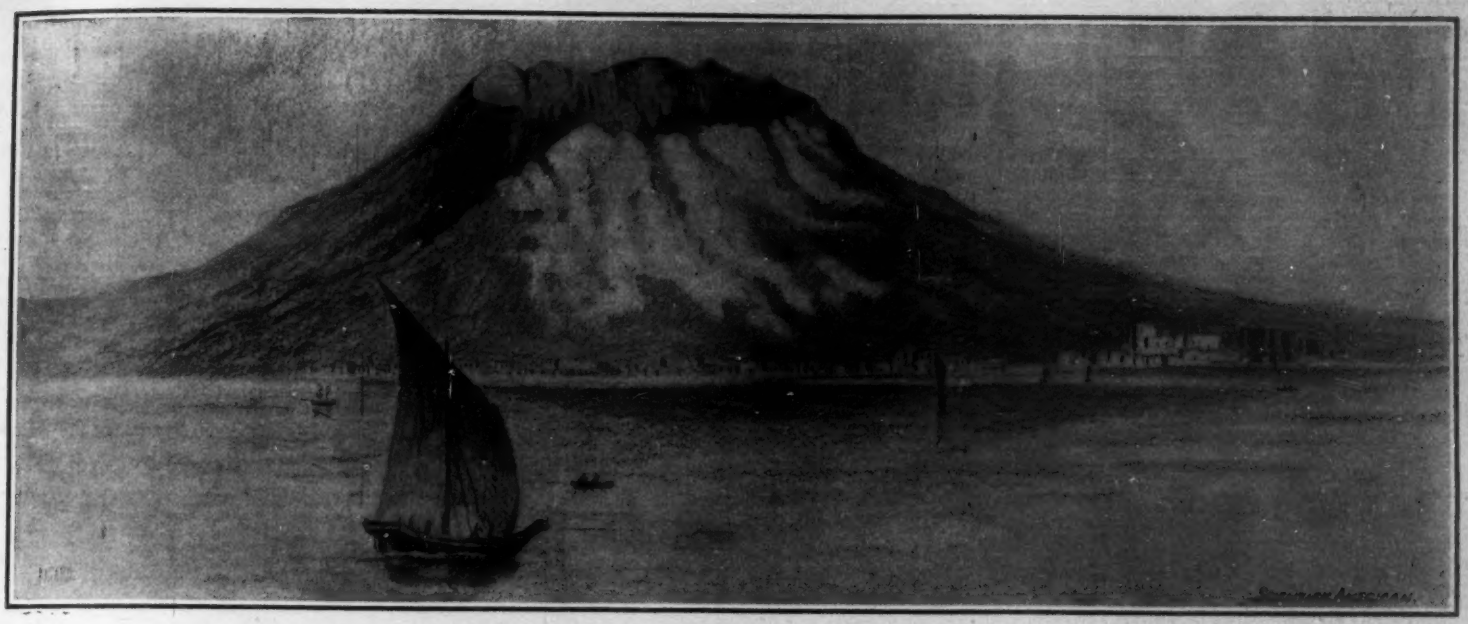
In fact, Dr. Pearce Bailey, who is quoted as an authority on forensic medicine, expresses the belief that "the very best adjuster that a railroad can have is a medical man with knowledge of negligence law."

In conclusion, the author submits the following recommendations to the railroad companies:

"a. The instruction of trainmen and shopmen in first aid to the injured.

"b. The incorporation in this instruction of practical points on accident law.

"c. The employment in the claim department of a medical man, skilled in theory and practice of surgery and adept in negligence law, whose duty it will be to assist and advise counsel of the road, to bring about co-operation between the legal and surgical staffs of the closest possible nature, and last but not least, to be possessed of a fund of sound sense and a personality that will enable him to deal direct with the claimant."



Probable Appearance of Vesuvius Before the Great Eruption of 79 Which Destroyed Pompeii and Herculaneum.

Vesuvius from the Harbor of Naples at the Beginning of the Outburst of 1872.

Vesuvius in a Quiescent State, Viewed from the City of Naples.

VESUVIUS: PAST AND PRESENT.

Business and Personal Wants.

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Inquiry No. 8033.—For manufacturers of metallic calcium.

Inquiry No. 8034.—For manufacturers of machinery for working agricultural and road forks.

Inquiry No. 8035.—Wanted, address of manufacturer of Gardiner Gyroscope.

Inquiry No. 8036.—For manufacturers of metal as thin as tin foil or thinner.

Inquiry No. 8037.—Wanted, address of makers or patentees of apparatus or system for drying fruit, in which the air passing through is first freed of its moisture by contact with concentrated sulphuric acid, running down a series of shelves arranged in tower fashion.

Inquiry No. 8038.—For manufacturers of a sheet of substance, such as paper or fabric, one side of which is to be parchmed or oiled, and the other side of which is to be coated with a glutinous-glycerine substance.

Inquiry No. 8039.—Wanted, makers of automatic lathes for pill and ointment boxes, tack barrels, etc.

Inquiry No. 8040.—For manufacturers of stump sawing machines.

Inquiry No. 8041.—For manufacturers of emery wheels, such as are clamped on fly wheel of a sewing machine.

Inquiry No. 8042.—For manufacturers of a transfer press.

RECENTLY PATENTED INVENTIONS.

Household Utilities.

MEAT-TENDERER AND VEGETABLE-CHOPPER.—F. BRUCKMAN, East St. Louis, Ill. The patentee's invention has reference to meat pounders and choppers and vegetable-choppers, such as used in kitchens for preparing food. The object of the invention is to produce a device of this kind which is simple in construction and which will present a plurality of blades operating simultaneously upon the food.

Machines and Mechanical Devices.

GAS-FILTER.—G. A. STEBBINS, Watertown, N. Y. This patentee's invention relates to an attachment for sulfite pulp digesters. It is designed to prevent the chips from clogging up the gas outlet at the top of the digester. The inventor provides a filter comprising a perforating member through which the gas may escape and a device movable toward and from said member having means for clearing the perforations from any chips which may enter and clog the same.

ICE-CREAM FREEZER.—J. E. DUNNE and C. A. FLETCHER, Chicago, Ill. The invention relates to ice-cream freezers, and more particularly to those intended to be built upon a large scale. The invention further relates to various constructional improvements, whereby the capacity of the freezer is greatly increased and the apparatus is rendered more easily accessible and more readily handled than freezers as heretofore constructed.

DRILL-SHARPENING MACHINE.—J. J. BROSSOIT, Grand Rapids, Wis. The invention relates to a machine for repairing drills—such, for example, as those disclosed in Mr. Brossoit's former patents. The present invention relates to an improved means for moving the carriage which holds the drill and also to an improvement in the dies which are employed for striking the V-point on the drill during process of sharpening the same.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Durability and Economy in Painting.

BY ROBERT JOB, CHIEF CHEMIST PHILADELPHIA AND READING RAILROAD COMPANY.

One of the great tendencies to-day in almost every line of manufacture is toward the improvement of processes and methods. The object very often has been largely the prospect of increased output resulting from the new devices and, hence, usually an ultimate lowering of the cost of production. In face, however, of greater competition in many cases, and the generally increasing knowledge of consumers concerning the properties of materials, there has been a growing disposition to consider other things in addition to the important question of first cost. As a consequence, there is an effort upon the part of the reputable manufacturer to get the cost as low as it is compatible with maintaining good quality, relying more and more for volume of sales upon the actual merit of the goods. The tendency is to get the greatest durability that can be produced, and then to sell at a price determined by competition; but, in any event, not to sacrifice durability, since the reputation of the manufacturer and, hence, the prospect of future profit will be based ultimately upon the actual service results of the product.

The above-mentioned disposition has led, naturally, to many changes in the paint industry, since the fact is now well recognized that length of service and general durability may vary tremendously in paints of identically the same chemical composition, owing to mere differences in the physical properties of the pigment. For instance, one pure white lead paint may be much inferior to another pure white lead paint, and the cause may be found to be the less careful preparation and grinding of the one than the other. This truth was brought forcibly to our attention a number of years ago by the peculiar service of three paints which were used for a period of about ten years upon the bridges and structural work upon our lines. The study was presented in detail before the Franklin Institute and is found in its Journal of July, 1904. The essence is that three paints of closely similar composition, side by side upon bridges all over our lines, gave radically different service results, for one had a life of less than one-half of that given by another, and the third was intermediate between the others in durability. Upon studying the matter closely, we found that the differences in efficiency were due to characteristic variations in the physical properties of the pigments. The one which gave the best service was almost impalpably fine, while that which gave defective service was relatively coarse, and the third was intermediate between the others in fineness. These paints contained only about twenty-three per cent of sesquioxide of iron, as the coloring matter, and the remainder was composed of inert matter, consisting of clay, silica, and sulphate of lime. Strangely enough, also, each of the three paints was made by various manufacturers in the same mills and with practically the same amount of grinding and, consequently, the milling cost of each was closely similar, and the difference in the ultimate fineness was thus due to the greater natural fineness of the one pigment beyond that of the others. The sesquioxide of iron in the first was in the form of a soft unburned ocher mixed with clayey matter, while in the others it was calcined and the particles were harder and more difficult to crush, and there was present a larger proportion of free silica and of sulphate of lime, both of which materials resist very fine grinding. Furthermore, the one paint above referred to had a longer average service life than any of the other paints then in use upon our lines, including pure white lead, white lead-zinc oxide mixtures, and various iron oxide paints.

The deductions from this study were very clear and have been borne out by subsequent experience.

It was evident that durability did not bear any relation to the cost of the paint, since one of our cheapest paints had proved the most lasting and gave the best protection, or, in other words, a paint containing only twenty-three per cent of sesquioxide of iron, with the remainder largely clay, gave far more efficient service under the same general conditions than paints of much higher first cost. It is perfectly possible to have an exceedingly durable pigment composed, we will say, of sesquioxide of iron one hundred per cent pure, but in such case the durability would be due to the physical condition of the pigment and not to the fact that a high proportion of iron was present; for pigment of identically the same composition, that is, 100 per cent pure, but coarsely ground, would be found to have little protective value, and this entirely apart from any chemical reaction between pigment and oil.

Another teaching of these service results was that durability apparently bore no relation to the opacity of the pigment, or, to put this statement in another form, a pigment consisting of silica, clayey matter, or other inert material of low refractive power may give much longer service than that obtained with another pigment of greater capacity and, hence, of better apparent covering power. A case which occurred a number of years ago in our practice will illustrate this point:

The surface of a sandstone bridge had begun to weather somewhat, and it was desired to stop the disintegration. An ordinary paint, in the nature of the case, was unsuitable and, after trials of various materials with rather unsatisfactory results, we decided to make use of a paint composed of pure linseed oil and very fine inert matter, without any coloring. This paint, of course, was nearly transparent and did not mar the appearance of the stone, but it acted as a binder and the pigment gave excellent protection.

From the discussion above it will be evident that knowledge merely of the chemical composition of a given pigment may tell little or nothing regarding the ultimate service which may be obtained from the paint and, in order to insure satisfactory results, it is our practice to rely upon definite tests which have been found to hold the physical condition of the pigment to the quality proved desirable by service results, and to make analysis of the oil to be certain of its purity. In the case of the darker colored pigments we specify only enough inorganic coloring matter, such as sesquioxide of iron, to give the necessary opacity and the desired shade. By these means we are able to secure great relative durability at low first cost.

In the cases cited above we have seen that a comparatively small proportion of tinting matter combined with a large proportion of inert matter in good physical condition gave much better service results than did other paints in which a larger proportion of coloring material was present. In the latter instances, therefore, the excess of coloring matter beyond that required to give good covering and coloring properties, even after weathering, was of no more practical value than an equivalent proportion of any inert material of proper quality; in fact, it would be less desirable, since it would tend, as is well known, to increase the chemical action of pigment upon oil, and thus to decrease durability, merely adding to the cost of the paint without giving any useful equivalent. High-priced material may, of course, have great durability and often does have it, but in our experience selling price is at times entirely without reference to service value or to cost of production.

It is a matter of observation with us that some of the paints which have given the least satisfactory service contained a considerable proportion of inorganic coloring matter, but the defective service in one such case was due to the fact that the pigment was so coarsely ground that it settled to a hard mass in the bottom of the cans on standing over night mixed for use, and also "dragged down" from the painted surface before the oil had "set."

Also, shipments have been offered of similar material in paste form, and the pigment, owing to its coarseness, had settled to the bottom of the kegs in such a hard compact form that the paste could not have been broken down for use without running again through a mill. This pigment contained about fifty per cent sesquioxide of iron. If initially fine material had been used at the outset the pigment would have remained in suspension almost indefinitely, with only the same amount of milling; and the finer pigment, of the same composition, could have been obtained without additional cost.

Another example indicating the desirability of inert material of proper quality is given by black paint. In this pigment the proportion of actual carbon is unusually small, and no benefit ordinarily would be derived from a larger proportion, unless the paint were to be used for tinting or for other purpose in which pure coloring matter was essential. Even in the latter case no indication of its value in coloring properties would be given by the mere knowledge that the material consisted solely of the pure coloring matter, owing to the wide variation which exists in the strength of the different grades of such materials.

Our practice as regards black car paint pigment is to specify approximately ten per cent of black, the remainder being very finely divided inert matter; but in determining the coloring power of this pigment we place no reliance upon the proportion of carbon which is present, but hold the tint to a definite depth. Paint of this quality is more satisfactory in working than pure black pigment, and the results in service are equally durable and the cost is relatively low.

For many purposes, of course, dark-colored pigments are inadmissible and pure white, or the lighter shades, are desired. In such cases white lead is naturally selected as a base, owing to its opacity; but, as the composition of pure white lead varies within considerable limits, and as the physical condition of the pigment sometimes differs greatly, the mere statement of purity is by no means necessarily a reliable index of quality. Moreover, paint to-day is generally exposed to sulphur fumes, particularly upon railways and in towns and cities, and a pigment composed wholly of white lead is generally undesirable, since blackening results rapidly. A mixture with zinc oxide or with some inert pigment is more lasting, owing to slower chemical action between pigment and oil, and also the whiteness is retained for a much longer time. Paints of this type have good covering properties and give good general service.

Enough now has perhaps been said to cover some idea of the properties which we consider essential to durability and of the general characteristics which are desirable. Adulteration of paint materials, such as linseed oil, turpentine, and japan, is, unfortunately, all too prevalent, and we find it necessary, in order to secure materials fully up to our specified standards, to make a uniform practice of testing each shipment upon receipt and, by this means, bar out the grades lacking in quality.

Linseed oil may be adulterated with mineral oil, fish oil, cottonseed oil, and other materials which both lower its cost and detract from its lasting qualities. Turpentine may contain benzine or other mineral oil, and japan may be of very low strength and also adulterated with various injurious constituents. Such barefaced adulteration as this constitutes direct fraud upon the purchaser of supposedly pure materials, and should be repressed by proper legal control. There seems to exist, however, in the popular mind a good deal of misconception as to the meaning of "adulteration' as applied to paints. To our mind the word means the addition of some substance detrimen-

tal to durability or other desirable property of the paint, or the foisting upon the consumer by means of misrepresentation of some article which he does not wish to purchase and would not purchase did he know its real character. The incorrect use of the term is found when a claim is made that a mixture, say of white lead and zinc oxide, or a combination of either with a proper proportion of inert material of suitable physical properties, constitutes an "adulteration." It is an adulteration if the paint is labeled "Pure White Lead," but if the label reads "Pure White Paint" it is perfectly correct; and if the properties of the paint are good in other respects, such as fineness, purity of the linseed oil, etc., the paint, as has been explained above, would be better adapted to many kinds of service than would white lead alone and, hence, such paint would be more valuable for the purposes of the consumer than pure white lead. In such a case the term "adulterated" would be preposterous if the paint were properly labeled. Or, if we consider the structural paint to which we have referred, containing twenty-three per cent of sesquioxide of iron and seventy-seven per cent of clayey matter: In the estimation of one unacquainted with technical paint matters this material might be considered a sesquioxide of iron paint grossly adulterated with clay and of little value, and, in order to get the most durable results, such a person would be likely to select the pigment which contained the highest proportion of oxide of iron, and this pigment, as has been explained, might or might not give good service, depending upon its physical character—provided, also, of course, that the linseed oil and the dryer were of good quality and in correct proportions.

The great value of the so-called "inert" materials for paint purposes was clearly recognized by Dr. Dudley years ago, and general results everywhere since that time have fully confirmed his deductions, assuming, of course, that the physical condition of the inert matter must be properly regulated in order to insure the most efficient service.

Up to this point in the discussion we have assumed that definite knowledge upon the part of the consumer has existed regarding the paints used for the various purposes: that each is bought under correctly drawn specifications, and that detailed examination is made of each shipment, to be certain that the desired quality is present. This is our invariable practice. But the question naturally arises, What course shall the small consumer take to secure the most satisfactory results? Suppose, for instance, one wishes to buy a gallon of house paint. Shall he obtain a can of "ready-mixed" paint from a dealer, or shall he buy separately his paste, oil, and japan and make the mixture himself? This field is an open one, sometimes with many pitfalls, for it is unfortunate that some of the mixed paints have little merit and, consequently, no definite course can, in the nature of the case, be specified. Our feeling, however, is that it would be safer to buy a ready-mixed compound made by a reputable manufacturer rather than purchase separately the constituents. In case of a purchase of ready-mixed paint, any difficulty or poor service would be referred directly to the manufacturer and, consequently, it would be much to the interest of the latter to put upon the market only such material as he was willing to cover by his guarantee; for if this were not done, his future sales in that locality would probably be diminished. In other words, it would be clearly to his ultimate profit to pay careful attention not merely to the composition and general quality of the pigment, but also to be certain that the linseed oil was pure and well settled, that the japan was of good strength and free from constituents injurious to durability, and that only enough japan was added to give proper character to the oil. If each of the constituents was purchased separately adulteration would be likely to be present in any, and, hence, after the application of the paint it would be a

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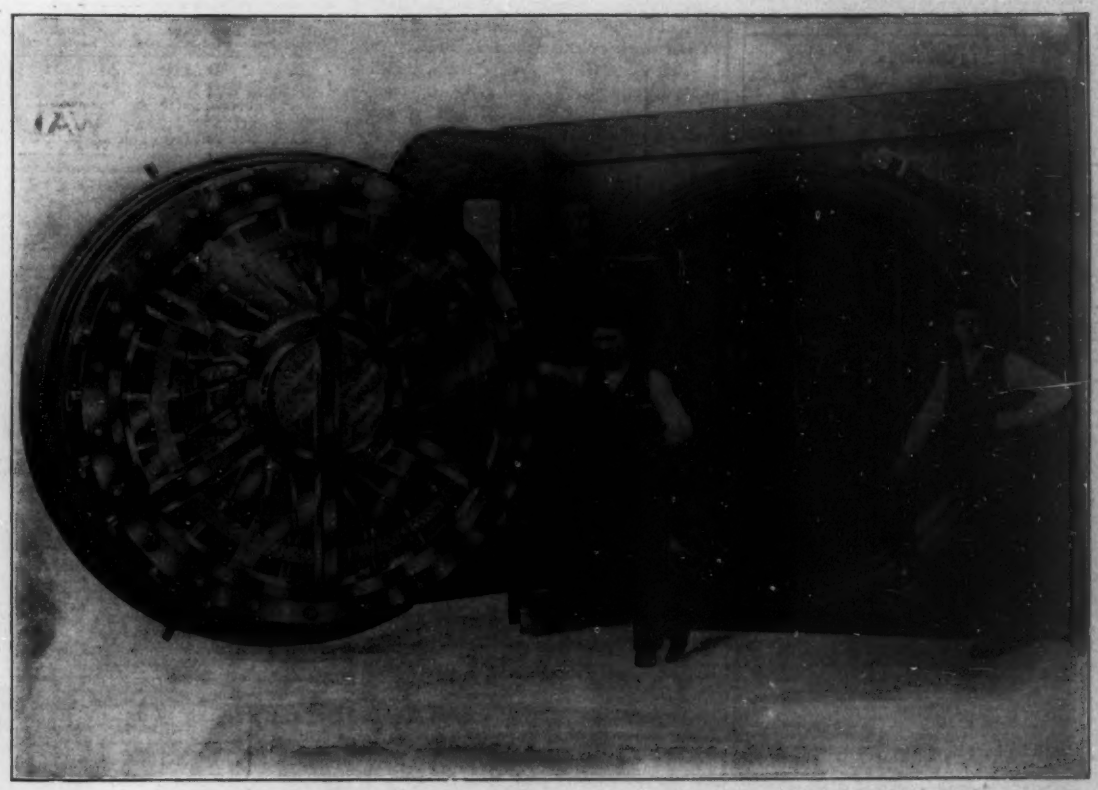

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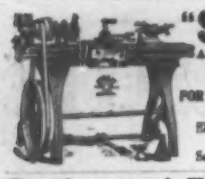

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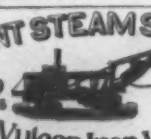

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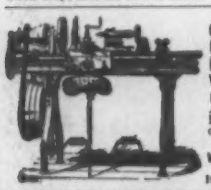

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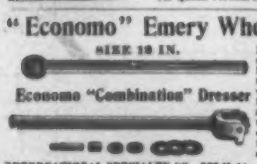

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difficult matter to fix the responsibility in case of failure. Another point in favor of the paint in ready-mixed form is that the materials would be run through the mills together and would, undoubtedly, be more uniform than if the small consumer prepared his own mixture, while also in the latter case there would be greater liability of poor results, due to excess of japan.

The entire subject of painting, particularly as applied to the protection of iron and steel, is receiving great attention upon the part of engineers. This is indicated by the very general interest taken in the work of the American Society for Testing Materials in connection with this subject, and by the activity of many manufacturers in following out various lines of investigation work at their laboratories; for it seems to be well recognized that he who aims at excellence of product through critical study of the properties necessary to obtain such service will, almost of necessity, find an increasing demand for his wares.

Reading, Pa., March 9, 1906.

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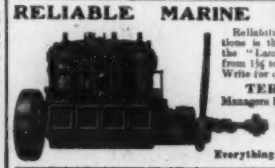

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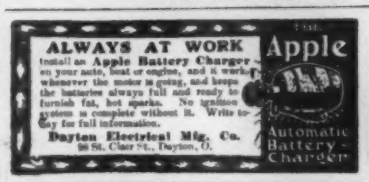

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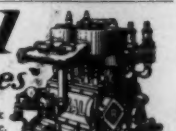

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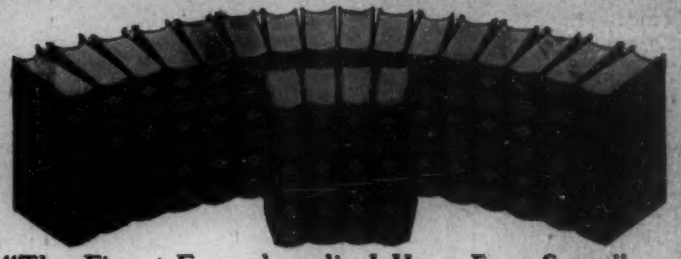

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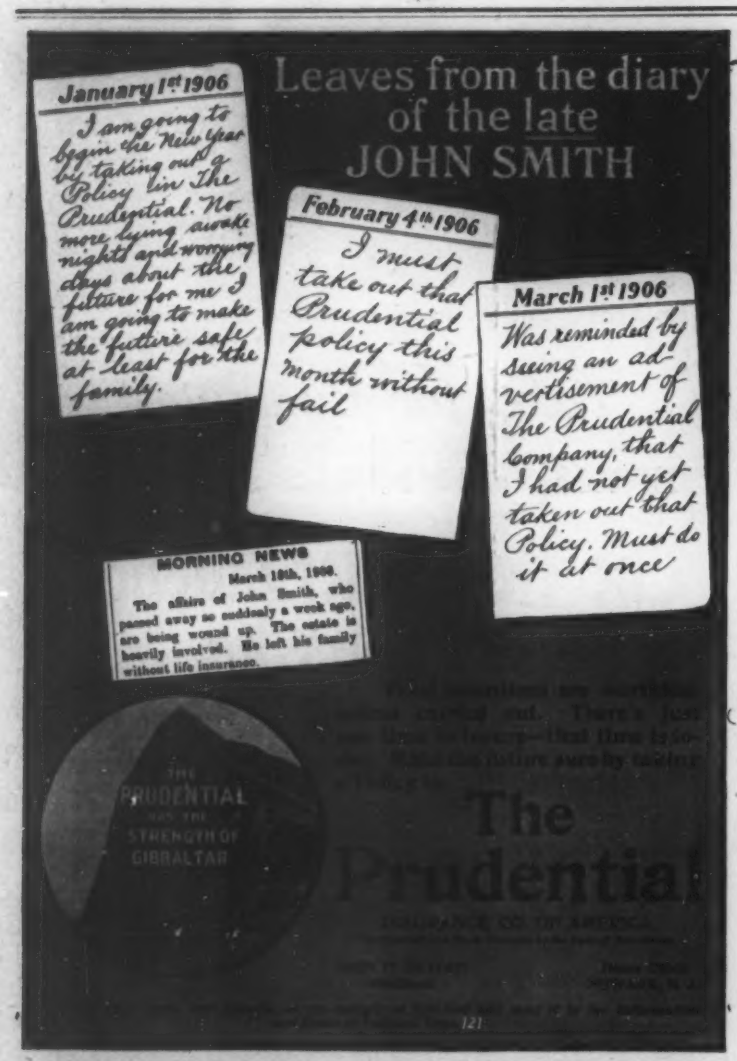
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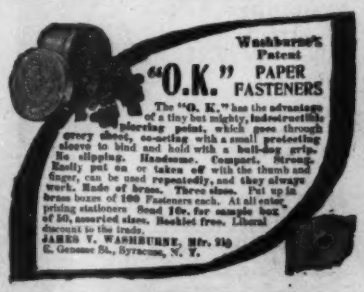

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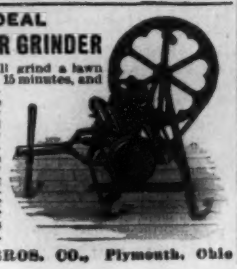

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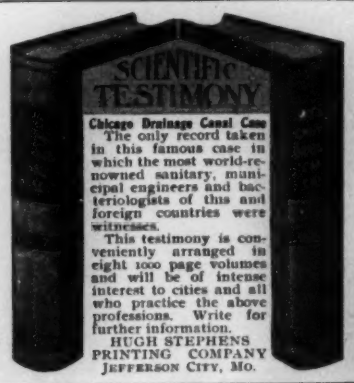

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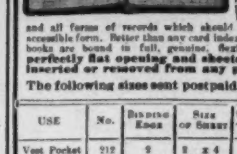

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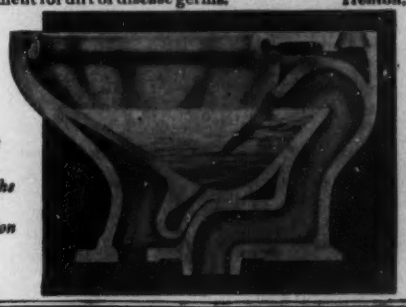

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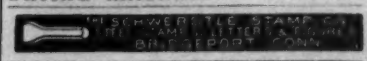

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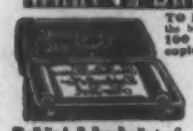

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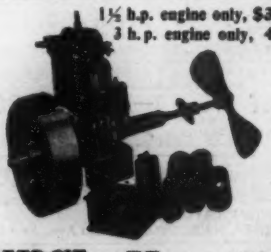

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